VOL. XXI, PARTS III & IV Published 8 June 1938

The British Mycological Society

(*Recognosce notum, ignotum inspice*)

TRANSACTIONS

Edited by

J. RAMSBOTTOM, B. BARNES and H. WORMALD

Price to non-members, Fifteen Shillings

CAMBRIDGE UNIVERSITY PRESS
LONDON: BENTLEY HOUSE
CHICAGO: THE UNIVERSITY OF CHICAGO PRESS
(AGENTS FOR THE UNITED STATES)
BOMBAY, CALCUTTA, MADRAS: MACMILLAN
TOKYO: MARUZEN COMPANY LTD.

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SOME CHYTRIDIACEOUS FUNGI FROM NORTH AFRICA AND BORNEO

By F. K. SPARROW, Jr.

(With 2 Text-figures)

Since our knowledge of the distribution of Chytridiaceous fungi is so fragmentary, it would seem of interest to record in this brief note the occurrence of certain of these organisms in two rather unusual geographic localities.

The material from North Africa appeared in gross water cultures started from a bit of vegetable "trash" collected in a small pond near Tangier in April 1933, by Mr E. F. Warburg, M.A., of Trinity College, Cambridge. The specimens from Borneo, excellently preserved in formalin, were found in a collection of fresh-water red algae made by Mr P. W. Richards, M.A., also of Trinity College. To these two gentlemen the writer wishes to express his best thanks.

Tangier

In the cultures started from a bit of moist vegetable trash, there appeared after a few days a profuse growth of *Chlamydomonas* spp. and *Protoderma* sp. While several Chytridiaceous fungi were found on these two algae, in only one were significant phases in the life history observed. This fungus, however, proved to be of very great interest, and a comparison with other related forms indicated that it belonged in a genus of its own which was possibly allied to *Sporophlyctis*. The name *Sporophlyctidium africanum* has been given to it in a previous paper(1).

The fungus has an exceedingly simple structure and mode of development. The zoospore, lying free in the water, produces a highly refractive, wedge-shaped germ tube (Fig. 1 *a*, *b*). The tip of this structure penetrates the cell wall of the alga. No further development within the host cell takes place. Subsequent growth results in a differentiation of the germ tube and the body of the spore, the former becoming more isodiametric and stalk-like, the latter larger and obpyriform (Fig. 1 *d*). Although no cross-wall could be detected separating these two portions of the thallus, when the fungus had attained its full size the granular content of the more distal portion was in marked contrast to the refractive material within the stalk. Ultimately, the content of the distended part became divided into four to

six spores which were liberated through a small lateral pore formed in the wall. Outside, they remained grouped for a time before the orifice but ultimately this cluster fell apart and the spores floated away. Each was spherical, 2 μ in diameter, possessed a minute oil globule and was devoid of cilia. The latter point was ascertained after a close study of a number of spores from various sporangia. After discharge the sporangium and its stalk collapsed (Fig. 1 *c*, *d*).

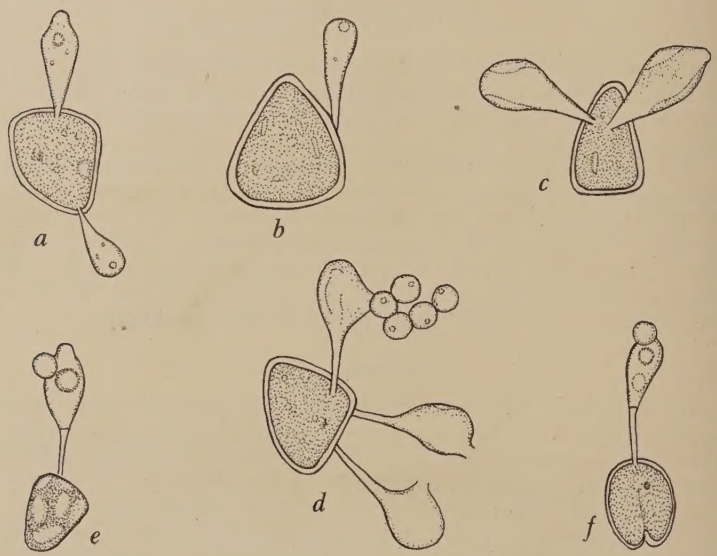

Fig. 1. *Sporophlyctidium africanum*, parasitic on *Protoderma* sp., Tangier. *a–d*, ×2500; *e*, *f*, ×1500. *a*, *b*, stages in the formation of the sporangia; *c*, empty sporangia; *d*, discharging sporangium (upper), two empty sporangia below; *e*, *f*, possible resting spores with companion cells.

What may possibly be the resting spores of this fungus were observed in a few instances several weeks after the sporangial stage had been found. These were similar in shape to the sporangia, 7 μ long by 4 μ in diameter, and possessed a somewhat thickened wall and a single large oil globule in the content (Fig. 1 *e*, *f*). Attached laterally to the upper portion of the spore was an empty, spherical cyst which undoubtedly functioned as a "male" or "companion" cell. Germination of these spores was not observed, nor were early stages of the sexual process seen.

In its main features this interesting organism closely resembles *Sporophlyctis rostrata* Serbinow, a form found parasitic on *Draparnaldia* in Russia(2). In the latter fungus the relationship of the parasite to the alga is similar to that of the present form, only the tips of the rhizoids penetrating the host cell. In the shape of the sporangium, position of the discharge pore, and the non-ciliation of the zoospore this resemblance is further emphasized. However, in certain essential features, the African fungus differs markedly from *Sporophlyctis*. In the former, the structure which makes contact with the host cell is never branched or rhizoidal in character, but unbranched and "inflated" (broad). Nor are the zoospores of this fungus formed in a vesicle extruded from the sporangium, but rather are fully formed within the latter body, and discharged individually. Further differences between the two are found in the sexual stage. In *Sporophlyctis* there is a copulation between two thalli, a large, male plant similar to the sporangium and a smaller, narrowly clavate, spiny-walled female one. A portion or all of the content of the larger thallus passes over into the smaller one and the latter is ultimately transformed into a resting spore. While early stages in the formation of the resting spore of the African fungus were not observed, it is apparent that the receptive individual is the larger of the two; also, the resting spore thus formed is smooth-walled. No evidences of any rhizoidal development were found on this male cell, although such may have been present in the early stages of conjugation.

These differences between the African fungus and *Sporophlyctis* seemed of such a fundamental nature that a new genus was proposed for its disposition. This has been given, in Latin, in a previous paper(1). For convenience, the following English generic and specific diagnoses are appended:

Sporophlyctidium. Zoospore lying free in the water, upon germination producing a single, unbranched, somewhat inflated tube, the tip of which penetrates the host cell; the body of the zoospore expanding and becoming the sporangium. Zoospores formed in the sporangium, at maturity liberated from the latter body after the deliquescence of a papilla; motionless, without cilia. Resting spore extramatrical, with a companion cell.

S. africanum. Sporangium narrowly pyriform, smooth-walled, colourless, the narrower end continuous with the unbranched germ tube; 5 μ long by 3·5–4 μ in diameter; forming a single subapical pore through which the spherical, uniguttulate, non-ciliated spores, 2 μ in diameter, are extruded. Resting spores similar in shape to sporangia, 7 μ long by 4 μ in diameter, with a spherical companion cell 3 μ in diameter; germination not observed.

Parasitic on *Protoderma* sp., Tangier, North Africa; collected by E. F. Warburg, April 1933.

Three other Chytridiaceous fungi were found in the same material that yielded *Sporophlyctidium*. The first of these (Fig. 2 *a*), also found on *Protoderma*, possessed broadly pyriform, extramatrical sporangia, 9 μ

high by 7 μ in diameter. At the apex were two broad, blunt papillae, 2·5 μ high by 3·5 μ in diameter. Within the algal cell a short peg was noted but whether or not it was branched could not be determined. No further stages were observed.

The other two fungi were found on resting cells of *Chlamydomonas* sp. One (Fig. 2 *c*) possessed extramatrical, somewhat angular resting spores about 12 μ in greatest diameter. The spores were thick-walled and their surface provided with irregularly disposed, blunt, solid bullations. Where the host content was contracted, a branched rhizoidal system could sometimes be detected attached to these resting spores. The sporangial stage was not observed. The other fungus found on *Chlamydomonas* (Fig. 2 *b*) had smooth, thick-walled, spherical, extramatrical resting spores, 6–9 μ in diameter, each of which possessed a spherical, empty companion cell, 2·5–3 μ in diameter. Parts of a branched rhizoidal system could occasionally be detected within the alga. No sporangial stage was found.

These three fungi are probably all species of *Rhizophidium* and referable to European species, but until more is known of their life history, they cannot be identified.

Borneo

Four Chytridiaceous fungi were found in the material, preserved in formalin, brought back by Mr Richards.

In material of green algae from a drainage ditch at the edge of the forest near Claudtown, Sarawak, collected in December 1932, many specimens of a *Synedra* which were infected with *Rhizophidium fusus* Zopf were found. The sporangia (Fig. 2 *d*) were fusiform, 10–15 μ long by 4–6 μ at their greatest diameter, and were nearly always slightly tilted. The intramatrical system consisted of a series of delicate, branched rhizoids. These specimens differed in no significant respect from the common European or American ones.

In material of *Cosmarium* sp. from this same locality there were found many discharged sporangia of a very small species of *Rhizophidium* (Fig. 2 *e*) which appeared to be closely allied to *R. carpophilum* Zopf, or *R. minutum* Atk. The nearly spherical sporangia were 5–7 μ in diameter, with a relatively broad apical pore. The rhizoidal system was delicate and sparingly branched. In a few undischarged mature

Legend for Fig. 2.

Fig. 2. *a*, sporangium of *Rhizophidium* (?) on *Protoderma*, Tangier, ×2500; *b*, resting spores of *Rhizophidium* sp. (?), with companion cells, on *Chlamydomonas*, Tangier, ×2500; *c*, resting spore of *Rhizophidium* sp. (?), on *Chlamydomonas*, Tangier, ×1300; *d*, *Rhizophidium fusus* on *Synedra*, Borneo, ×1300; *e*, *Rhizophidium* sp. (?) on *Cosmarium* Borneo, ×1300; *f–h*, sporangia of *Rhizophlyctis borneensis* n.sp., on diatoms (*diat.*), Borneo, ×1300; *i*, *Chytridium Schenkii* (?), on *Cosmarium* sp., Borneo, ×1300.

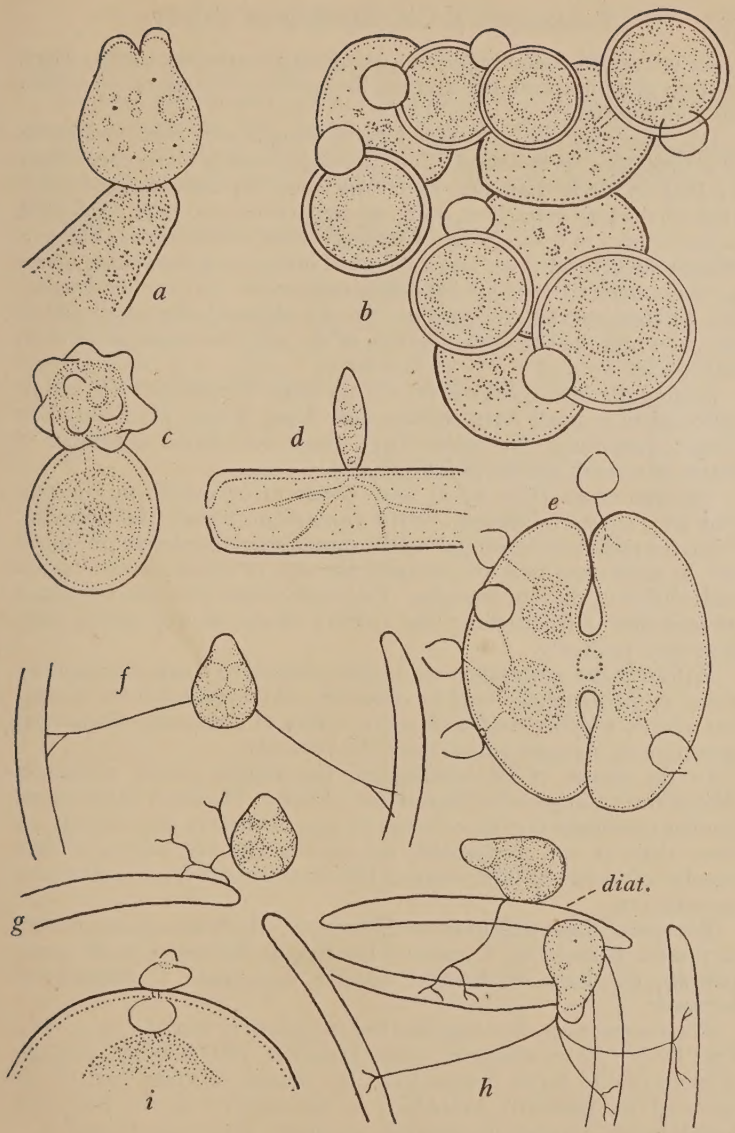

Fig. 2. (See opposite for legend.)

sporangia, eight to ten regularly placed oil globules were seen. Each of these globules probably marked the position of a zoospore within the sporangium.

On *Cosmarium* from the same locality several very small specimens of a *Chytridium* were found. The sporangia, which were only about 8 μ long by 5 μ in diameter, were somewhat elliptical, inclined at an angle to the wall of the host, and possessed a subapical pore. Attached in the vicinity of this pore was a strongly convex operculum (Fig. 2*i*). Within the host cell there was a spherical subsporangial swelling about 5 μ in diameter from which several rhizoids arose. In its general aspect this Chytrid resembles *Chytridium Schenkii* although the small size of the parts and the subapical position of the exit pore mark it off from this species.

Among diatoms epiphytic on a fresh-water Floridean (No. 2585), collected in a small forest stream near Long Kapa, Mt Dulit, Ulu Tinjar, Sarawak in November 1932, there were found a number of plants of a small species of *Rhizophlyctis*.

The sporangia (Fig. 2*f–h*) were pyriform or bursiform, 12–15 μ long by 7–10 μ in diameter, with a prominent, broad, blunt papilla. From the middle or lower part of the sporangium there were produced one to three very delicate rhizoids, the tips of which made contact with different diatom frustules. Generally these rhizoids remained unbranched until reaching the vicinity of the diatom where they branched profusely.

Within many sporangia four to six somewhat spherical zoospores, about 4 μ in diameter, could be observed. On several of these aguttulate spores, which were found at the orifice of a partially discharged sporangium, a single cilium could be detected.

In the shape of its sporangium this fungus closely resembles *Rhizophlyctis mastigotrichis* (Nowakows.) Fischer. However, it has much smaller sporangia (12–15 × 7–10 μ, cf. 40 μ diameter), the rhizoids are more delicate and attenuated, not swollen distally, and a smaller number of zoospores (four to six, cf. fifty or more) are produced in each sporangium.

Because of these well-marked differences, which are apparent even in preserved material, I consider the fungus distinct from *R. mastigotrichis*, its closest fresh-water relative, and name it *Rhizophlyctis borneensis*.

R. borneensis n.sp. Sporangium free, pyriform or bursiform, 12–15 μ long by 7–10 μ in diameter, smooth-walled, with a broad papilla; rhizoids one to three, arising from the middle or lower part of the sporangium, generally branching in the vicinity of the host cell, polyphagous. Zoospores spherical uniciliate, four to six formed in a sporangium, 4 μ in diameter. Resting spore not observed. Parasitic on diatoms, British North Borneo. Coll. P. W. Richards.

RHIZOPHLYCTIS BORNEENSIS sp.nov.

Sporangiis liberis, piri- vel bursiformibus, 12–15 μ longis, diametro 7–10 μ, membrana levi cinctis, papilla lata ornatis; *rhizoidibus* 1–3, sporangio medio vel parte inferiori productis, juxta matricem fere ramosis, polyphagis; *zoosporis* sphaericis, uniciliatis, in sporangio 4–6, diametro 4 μ.

Hab. ad Diatomaceas in Borneo Brit. Septentr.

REFERENCES

(1) SPARROW, F. K. (1933). "New Chytridiaceous Fungi." *Trans. Brit. mycol. Soc.* XVIII, 215.

(2) SERBINOW, I. L. (1907). "Organisazija i rasitie neleotorich gribow Chytridinere Schroet." *Scripta Bot. Hort. Petropol.* XXIV, 116.

A RECORD OF TWO YEARS' CONTINUOUS OBSERVATIONS ON *BLASTOCLADIA PRINGSHEIMII* REINSCH

By DAPHNE LLOYD, B.Sc.
Royal Holloway College

(With 3 Text-figures)

The aquatic fungus, *Blastocladia Pringsheimii*, was first described in Germany by Reinsch (17) in 1878. Since then it has been described in Germany by von Minden (13, 14), in the United States of America by Thaxter (22), Kanouse (8, 9), Cotner (4), and Sparrow (18), and in Denmark by Petersen (15, 16). It was first recorded in Great Britain in 1930 by Barnes & Melville (1); and it has been reported three times more recently, in 1933–4 by Cooke & Forbes (3), in 1935 by Forbes (5) and in 1936 by Sparrow (21).

B. Pringsheimii has not, however, been described in detail in Britain, and its life history is not yet completely known. It seemed worth while therefore to make a further investigation of it. A special opportunity offered itself when the fungus was found growing abundantly under natural conditions in three pools and a stream in the grounds of Royal Holloway College. Although *B. Pringsheimii* is apparently saprophytic and will grow on various twigs and fruits in water, it has not yet been successfully cultured in artificial media.

Source of material

Attempts were made to cultivate the fungus in the laboratory in nutrient solutions and on nutrient agar media, but it was found impossible to maintain normal growth for any length of time. Plants were transferred from the pond to a solution of soil extract containing a 0·5 % solution of potassium nitrate and to a 1 % pea solution, and they were mounted in their own pond water on various agar media. Zoospores swarmed and germinated in these solutions and on these media, but, by the time the first sporangium was initiated, or earlier, growth ceased and the young plants showed an unhealthy accumulation of oil. Agar films containing and supported by a mesh of cotton-wool were suspended in the ponds to catch the zoospores, but these proved useless, as the agar slowly dissolved in the water before there

was any inoculation. Since none of these three methods proved very successful, the investigation was confined almost entirely to material brought from a pond in the botanical greenhouse. For two or three hours after collection normal growth appeared to continue, and the observations on this material were perhaps even more reliable than those made under the best of artificial conditions, as is evident from the later account of the swarming of the zoospores.

Method of investigation

The material was collected by von Minden's(14) method of suspending fruits in a wire cage six to twelve inches below the surface of the water. Tomatoes were finally selected as the best fruit, as their thin transparent skin renders observation of distribution of individual thalli easier, and the soft pulp separates relatively easily on dissection from the rhizoids of the fungus. The tomatoes were suspended for a period of three to fourteen days in the water of the greenhouse pond, of which the temperature varies between 13° and 18° C., when the skin became covered with white pustules each containing from one to forty independently established plants. The tomatoes were then washed in running tap water in the laboratory and replaced in water from the greenhouse pond and examined immediately.

Since material was abundant, culture in the laboratory was not essential, but it was useful for comparison. When it was found that sporangia failed to discharge zoospores in culture in either pond water or sterile distilled water, that the water became cloudy with bacterial zooglea after the tomatoes had been kept in the laboratory for one or two days, and that inoculations of fresh tomatoes in sterile distilled water produced immature plants which developed only rudiments of sporangia, such cultures were discontinued, and aquaria were made with pond mud, pond water, green water plants, snails, etc. In these surroundings *B. Pringsheimii* continued to develop normally in the laboratory, and fresh sterile tomatoes were inoculated and produced normal healthy individuals.

For examination, two or three living pustules were mounted together in a hanging drop or in a moist chamber. The latter was generally used, because more individuals could be mounted together. Zoospores were discharged more readily in pond water, or in a solution of soil extract containing potassium nitrate, than in distilled water. Early stages of germination of zoospores were observed in pond water, while young plants have been obtained in a hanging drop of pond water on an agar film.

Complete plants were fixed and stained for the study of the development of the sporangium and of the zoospores within the sporangium. Since the wall of the sporangium is thin and permeable and the

diameter of the sporangium is small, sections are not essential provided that de-staining is adequate. Several fixatives were tried, and Nawaschin's fixing fluid was found most satisfactory. The material was well washed after fixation and stained by Newton's gentian violet method (La Cour(12)). The plant was mounted under a cover-slip in 0·1 % water solution of gentian violet for five minutes, and the cover-slip tapped gently, so that the sporangia spread out like a fan from the main axis.

Sections of plants were made for studying finer detail. Whole pustules were fixed, dehydrated and embedded in paraffin wax, or single plants were embedded after fixation in agar films, and the small blocks of agar were then embedded in paraffin wax. By the latter method approximately longitudinal or transverse sections of the main axis and sporangia could be more readily obtained. Sections were cut 6–10 μ thick and stained as above.

Observations

Form of thallus and position of sporangia on thallus

The thallus is differentiated into a rhizoidal system, which branches extensively as it penetrates into the substratum, and an emergent, sporangium-bearing axis, which exhibits such wide variation in its growth form that sometimes a second species, *B. globosa*, has been suspected. Thin-walled sporangia are developed at the tips of the usually branched main axis; they are cylindrical but vary considerably in length (300–110 μ) and breadth (30–15 μ). In addition, there may be produced simple and branched filamentous hairs and resting spores, the latter spherical, ovoid or shortly cylindrical with a wall of three layers, the middle layer being perforated.

Records of the variation in growth form and in frequency of resting spores and hairs have been kept for seventeen months, and these appear in Tables I and II. Table I gives the observations on material from the greenhouse pond, where the temperature varied between 13° and 18·5° C., and Table II gives observations on material collected from a pool in the botanical garden, with a temperature varying between 0° and 17·5° C. Each entry represents the range of variation within six pustules. Since the date of inoculation, and hence the true age of the plant, was not known, the maximum age or greatest possible age, that is, the time of immersion of the material, is given. The differences in growth form were referred to four types A, B, C and D; type A includes forms with a globose main axis; type B, forms with a sturdy main axis with a swollen or lobed apex; type C, forms with a sturdy branched main axis, and type D, forms with a slender, branched, filamentous main axis. Representative plants from these four classes are figured (Fig. 1).

Fig. 1. Four plants (× 80) of *Blastocladia Pringsheimii* Reinsch, showing variation in form and referred to, in the text, as types A, B, C, D. All bear empty sporangia. A and B have young sporangia. A has five resting spores. A, B and C show scars where sporangia have fallen.

A scrutiny of Tables I and II suggests that there is no periodicity in growth form or in frequency of resting spores and hairs. The forms of thallus included under B and C were most common in both pools, and the four types were developed at all seasons. Although there was

Table I

Date	Maximum age in days	Growth form (see Fig. 1)	Resting spores, frequency: F, frequent; O, occasional; A, absent	Hairs	
				Frequency	Type: S, simple; B, branched
1. v. 34	60	A, C	F	O	S
15. v. 34	3	A	A	O	S
17. v. 34	24	A, C	F	A	
27. v. 34	7	B, C	A	O	S
4. vi. 34	10	B, C	O	O	B
15. vi. 34	6	B, C	O	O	S
17. vii. 34	14	A, B, D	F	O	S & B
28. vii. 34	11	B, C, D	F	A	
4. viii. 34	7	D	F	A	
11. viii. 34	7	A, B, C	A	O	B
16. viii. 34	5	No inoculation			
27. viii. 34	11	B, C	O	O	S
3. ix. 34	7	A, C	A	A	
10. ix. 34	7	C, D	A	A	
17. ix. 34	7	B, C	A	A	
24. ix. 34	7	B, C	A	A	
1. x. 34	7	B, C, D	A	F	S
13. x. 34	12	B, C	A	O	S
26. x. 34	21	B	A	A	
30. x. 34	11	C	O	A	
13. xi. 34	10	B, C	A	O	B
29. xi. 34	10	B	A	A	
14. xii. 34	17	C	O	O	B
27. xii. 34	13	B, C, D	F	A	
7. i. 35	11	B, C	A	O	S & B
24. i. 35	17	C	O	A	
13. ii. 35	13	B, C	A	O	B
21. ii. 35	10	A, C	F	A	
6. iii. 35	12	C, D	O	A	
30. iii. 35	12	B, C	F	A	
8. iv. 35	10	B, C	A	A	
18. iv. 35	10	B, C	O	O	S & B
7. v. 35	10	B, C, D	F	O	S
24. v. 35	13	C	A	O	S & B
14. vi. 35	21	B, C	F	A	
27. vi. 35	14	C, D	F	O	B
12. vii. 35	14	C, D	F	A	
26. vii. 35	14	B, C, D	F	A	
9. viii. 35	14	A, C, D	F	F	S
11. ix. 35	33	A, B, C	F	A	

no seasonal periodicity in the development of resting spores, they were found most abundantly in the summer months; during the winter they appeared occasionally in the greenhouse pool and very occasionally indeed in the garden pool. The filamentous hairs were likewise not always present, and the occurrence of both branched and

unbranched hairs was related neither to the presence of resting spores nor to the time of year.

Since the globose type of thallus (A) occurred irregularly in these records, and as measurements of sporangia on these plants came within the range which has been described for *B. Pringsheimii*, it

Table II

Date	Maximum age in days	Growth form (see Fig. 1)	Resting spores, frequency	Hairs	
				Frequency	Type
1. v. 34	60	B, C	A	O	S
8. vi. 34	42	A, B, D	F	O	S
8. vi. 34	14	B	A	F	S
17. vii. 34	14	A, C	F	A	
28. vii. 34	11	A, C	A	O	S & B
4. viii. 34	7	B, C	F	A	
11. viii. 34	7	A, B	A	A	
16. viii. 34	5	A, B	A	O	S
27. viii. 34	11	B	A	A	
3. ix. 34	7	C	A	A	
10. ix. 34	7	C	A	O	B
17. ix. 34	7	C	A	A	
24. ix. 34	7	C, D	A	A	
1. x. 34	7	B	A	A	
13. x. 34	12	B	A	O	S
26. x. 34	21	B, C	O	A	
13. xi. 34	10	No inoculation			
29. xi. 34	10	D	A	A	
14. xii. 34	17	B, C	O	A	
27. xii. 34	13	B	A	O	S & B
7. i. 35	11	No inoculation			
5. ii. 35	19	C	A	A	
21. ii. 35	10	B, C, D	A	A	
21. ii. 35	21	B, C, D	A	A	
6. iii. 35	56	B, C	A	A	
30. iii. 35	14	C, D	A	O	B
8. iv. 35	10	B, C	A	A	
18. iv. 35	10	C, D	A	A	
7. v. 35	10	B, C	A	O	S & B
16. v. 35	9	C	A	F	S & B
12. vi. 35	14	B, C	F	A	
28. vi. 35	14	B, C	F	A	
12. vii. 35	14	A, C	F	A	
26. vii. 35	14	A, C	F	A	
9. viii. 35	14	A, C	O	O	S
11. ix. 35	33	C	F	A	

appears that the globose thalli are growth variations of *B. Pringsheimii* and not those of a separate species. All grades of variation between the globose type A and the more slender branched type D were found. A single pustule often contained plants which could be referred to two or more of these types. These variations in growth form appear, therefore, to belong to a single species.

Development of sporangium and zoospore

The observations on the development of the sporangium and zoospore made on living material have been amplified by a more intensive study of fixed and stained material. The sporangium arises as a small papilla which is very soon cut off by a wall from the main axis. It may then contain five to twenty nuclei, and the not infrequent absence of nuclei in the main axis immediately below the young sporangium suggests that it has been cut off by the wall after these few nuclei have passed in. Simultaneous divisions of these nuclei follow, and since the sporangium finally contains 150–250 nuclei, the nuclei must divide several times in the development of the sporangium. Dividing nuclei have been observed. It may be calculated that the formation of the final number from five nuclei would involve five simultaneous nuclear divisions. The determination of the frequency of these divisions has presented difficulties, as it has not been possible to follow the complete development of an individual sporangium in culture. There is evidently no diurnal periodicity in nuclear division, for material fixed at different times of day shows similar nuclear figures, and all stages of development of sporangia are seen at any one time. It is more probable that nuclear division occurs at definite intervals after initiation of the sporangium, and so is related to the stage of development. The frequency of nuclear division has been surmised thus: tomatoes, which had been immersed only two days in the pond, showed plants with papillae, while after four days' immersion they bore sporangia. These sporangia had developed from the papilla stage in two days at the most, and the nuclei must have divided at least twice a day. This simultaneous nuclear division is not confined to the sporangium alone; the main axis shows similar regularity in nuclear division.

After the last division has taken place in the sporangium, the nuclei go into a resting condition, and only a central nucleolus surrounded by a colourless region can be distinguished. At the same time the cytoplasm begins to divide up by cleavage vacuoles. Finally, when the protoplasm has been cut up into zoospores, there is a large proportion of deeply staining material in each zoospore. The large "sub-triangular" nuclei of Thaxter are readily discerned within the sporangium immediately before emergence.

The necessary conditions for dehiscence of the sporangium and emission of zoospores

It has frequently been said that the zoospores do not always emerge from the sporangium, and the necessary conditions for emergence are not yet fully understood. Thaxter (22) who first described the zoospores of *B. Pringsheimii* says: "As the fungus developes, growing as it almost

invariably does in tufts, it forms the centre of a dense mass of bacteria, which finally choke the sporangia completely; so that as a rule only those first formed are able to discharge their contents. As a result the zoospores commonly die without escaping." Petersen (16) made a similar observation. Kanouse (9) found that "zoospores swarm abundantly and readily in cultures that are two weeks old or more after the plants are transferred to distilled water and the temperature of the room in which the study is being pursued is considerably below normal". Cotner (4) showed that above 14° C. and below 11° C. there is incomplete cleavage of the protoplasm resulting in the formation of abnormal spores or absence of swarming, and thus explains the earlier observations.

Since old plants from the ponds and laboratory aquaria of Royal Holloway College showed, with rare exception, only empty sporangia, it must be concluded that the sporangia discharge freely under natural conditions. It is clear that, whereas the conditions existing during *emission* are not so important, those under which the *formation* of zoospores take place are very important. Swarming, when it occurred, was usually observed soon after the material had been brought into the laboratory. The sporangia generally ceased to discharge zoospores after the plant had been mounted for three hours, but exceptionally, the emergence of zoospores was observed in a hanging drop after eight, thirteen or twenty-two hours. Sporangia discharged zoospores even after the main axis had been torn in dissection, if the sporangia were in a mature state when the material was brought into the laboratory. Yet the conditions existing during emission must have some effect, because mature sporangia in fresh material did not always discharge their spores.[1]

Observations on living material were made at least once a week during the six terms of the sessions 1933–5. Fields of zoospores have been watched, and the zoospores from fifty-three sporangia were followed from emergence to germination. The temperature at which zoospores emerged was between 15° and 18° C. This is rather higher than the optimum temperature for zoospore formation given by Cotner, but the pond from which the plants were collected was at a correspondingly higher temperature (13°–18° C.) than his source of material, and this may account for the difference. The results are given in Table III and may be analysed as follows:

(1) Zoospores were emitted at all seasons of the year and at all times of day.

[1] Variations in temperature, light intensity and acidity of the medium probably influence the emergence of the zoospores, because these factors affect their later development. Zoospores do not germinate after prolonged exposure to artificial light, and the greatest development of sporelings was obtained on a medium with a *p*H value the same as that of the pond water, i.e. *p*H 8·0.

Table III

Date	Time of dehiscence of sporangium	Number of discharging sporangia observed	Germination of swarmers observed	Occurrence of resting spores on the same plant
12. xi. 33	6.45 p.m.	1	+	−
12. xi. 33	8.30 p.m.	2	+	−
13. xi. 33	7.20 a.m.	1	+	−
13. xi. 33	9.30 a.m.	2	+	−
13. xi. 33	...	2	+	−
29. xi. 33	10.45 a.m.	1	...	...
2. xii. 33	8.50 a.m.	1	+	−
2. xii. 33	11.5 a.m.	2	+	−
16. ii. 34	...	1	+	...
13. iii. 34	5.45 p.m.	Several	+	...
14. iii. 34	10.0 a.m.	Several	+	...
15. iii. 34	9.30 a.m.	Several	+	...
28. iv. 34	11.0 a.m.	1	+	...
3. v. 34	10.15 a.m.	1	+	...
5. v. 34	10.45 a.m.	1	+	...
7. v. 34	11.30 a.m.	1	+	...
2. vi. 34	10.45 a.m.	1	+	...
9. vi. 34	...	Several	...	...
23. x. 34	5.15 p.m.	3	...	−
23. x. 34	5.30 p.m.	2	...	−
20. xi. 34	9.45 a.m.	1	...	−
20. xii. 34	10.2 a.m.	2	...	−
5. xii. 34	5.15 p.m.	1	0	−
6. xii. 34	7.45 a.m.	1	+	−
6. ii. 35	9.55 a.m.	1	0	...
6. ii. 35	10.0 a.m.	2	0	...
6. ii. 35	10.2 a.m.	3	0	...
6. ii. 35	10.14 a.m.	4	0	...
6. ii. 35	10.52 a.m.	5	0	...
6. ii. 35	10.55 a.m.	6	0	...
6. ii. 35	10.57 a.m.	7	0	...
6. ii. 35	10.57 a.m.	8	0	...
20. ii. 35	9.30 a.m.	1	+	−
20. ii. 35	9.55 a.m.	2	+	−
20. ii. 35	10.0 a.m.	3	+	−
20. ii. 35	10.10 a.m.	4	+	−
20. ii. 35	10.50 a.m.	5	+	−
20. ii. 35	10.55 a.m.	6	+	−
13. iii. 35	10.15 a.m.	Several	0	−
8. v. 35	9.30 a.m.	1	0	−
8. v. 35	10.0 a.m.	2	0	+
8. v. 35	10.15 a.m.	3	0	+
8. v. 35	10.15 a.m.	4	0	+
9. v. 35	9.30 a.m.	1	0	+
9. v. 35	11.30 a.m.	2	+	+
12. vi. 35	10.15 a.m.	1	+	−
12. vi. 35	10.50 a.m.	2	+	−
12. vi. 35	10.55 a.m.	3	+	−
12. vi. 35	11.0 a.m.	4	+	−
12. vi. 35	11.40 a.m.	5	+	−
12. vi. 35	11.40 a.m.	6	+	−
12. vi. 35	11.50 a.m.	7	+	+
12. vi. 35	12.15 a.m.	8	+	−

(2) Except in eleven of the fifty-three instances, two or more zoosporangia discharged zoospores simultaneously or nearly so. There was therefore ample opportunity to observe fusion of gametes, if such they were.

(3) The zoospores usually settled down and germinated within two hours. Where no germination is recorded in Table III the zoospores had been watched for two to three hours by artificial light at a high temperature (sometimes as high as 37° C.).

(4) The sporangia, which discharged zoospores, were generally borne on plants which did not produce resting spores. But where resting spores were present, the zoospores behaved similarly to those from plants without resting spores.

Phenomena of dehiscence of sporangium and of swarming and germination of the zoospores

Discharge. A single apical papilla is formed before the spores are differentiated within the sporangium. This papilla is a thicker and more refractive region of the wall and projects into the sporangium like a plug (Fig. 2*a*). If the contents of the sporangium are plasmolysed, two distinct parts of the plug can be made out; one part remains attached to the wall, while the other is withdrawn with the protoplasm. Barrett(2) made a similar observation on the doubleness of the plug in *B. strangulata* (*Allomyces*), and suggested that the inner part of the plug gives rise to the vesicle membrane.

The formation of a vesicle, into which pass the first few zoospores that emerge from the sporangium, was reported by von Minden(14); and I have always observed zoospores to emerge in this manner. The first zoospores to be liberated are seen as a small nearly spherical mass at the apex of the sporangium (Fig. 2*b*); the thin vesicle membrane can barely be distinguished, but attached to it is a small plug, which is probably the outermost part of the original plug or papilla of the sporangium. As more zoospores pass in, the spherical vesicle swells, becoming pyriform (Fig. 2*c*, *d*). Meanwhile the plug becomes less and less definite until finally it is no longer distinguishable, and the whole plug appears to have been absorbed into the vesicle membrane. When the vesicle is fully expanded, it bursts and the zoospores gradually separate and swim away from the mouth of the sporangium (Fig. 2*e*, *f*). In one observation (represented diagrammatically in Fig. 2*b–g*), the vesicle reached its full expansion and most of the zoospores separated in three minutes; some of the zoospores, which had entered the vesicle, did not swim away, and no more zoospores emerged from the sporangium.

In general the zoospores which remain in the sporangium have been observed to squeeze out singly by their own movement (Fig. 2*h*). The very active zoospores near the centre of the sporangium push the

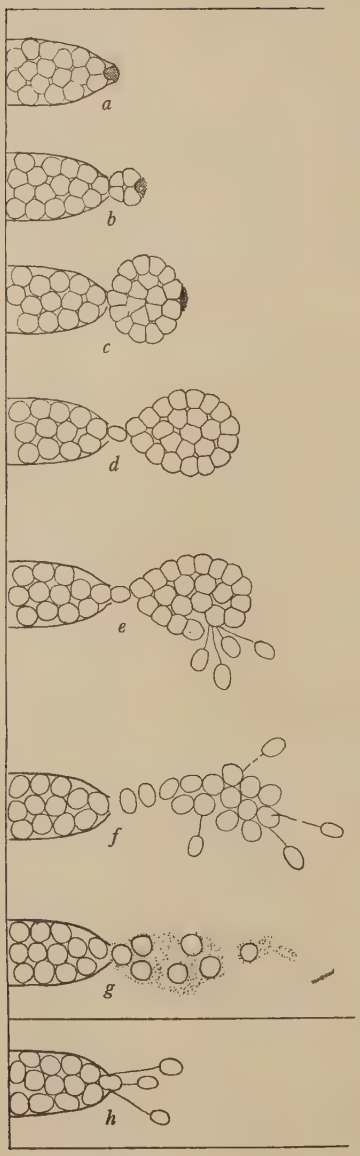

Fig. 2. *a*, the tip of a ripe sporangium. *b–g*, the tip of a sporangium drawn at intervals during the liberation of the zoospores in a vesicle: a process lasting about three minutes. *h*, the tip of a sporangium liberating the zoospores one by one.

less active ones through the opening. The zoospore is egg-shaped and the more pointed end bearing the single flagellum issues last from the sporangium. The flagella of emerging zoospores frequently become entangled and zoospores may be seen tugging and swinging on their flagella, which are about four times as long as the spore.[1] Finally they become free from one another and may swim continuously for about two hours, but the duration of swarming varies considerably.

Swarming. Motile zoospores of *B. Pringsheimii* were first described by Thaxter (22) as ovalor elliptical, and generally biflagellated, the two flagella arising side by side from the smaller end of the spore. He described the nucleus as very large and "sub-triangular" in outline, its base connected with that of the flagellum by a fine strand of cytoplasm. Petersen (16) described the zoospores as uniflagellate and von Minden (14) considered uniflagellate zoospores to be typical, while Kanouse (9) described forms with one, two and three flagella. Cotner (4) has shown that they are uniflagellate and uninucleate when allowed to develop normally under optimum conditions, but at temperatures above 14° C. and below 11° C. incomplete cleavage of the protoplasm occurs, so that a number of giant spores are formed with two to three nuclei and a corresponding number of flagella.

In this investigation zoospores have been observed to range in size from 5×6 to $6 \times 9 \mu$. As these observations were made on living material, the number of nuclei could not be determined, and it is possible that the larger zoospores may be the abnormal forms which Cotner has described. The zoospore moves in a fairly uniform manner and an asymmetric spore may be seen to rotate on its longitudinal axis. At any time after emergence a zoospore may show amoeboid movements, while other zoospores are still swarming, but frequently there is no amoeboid stage.

Fields of motile zoospores have been watched to see if zoospores from different sporangia or from sporangia which are borne on different plants show any tendency to fuse. The zoospores vary somewhat in size and some zoospores are less active than others, but from their behaviour there has been no suggestion of a larger female and a smaller male gamete. The flagella of two zoospores have frequently become intertwined; they have, however, always separated later by their own tugging or by the intervention of a third zoospore. Two zoospores have often been seen to come to rest side by side and undergo amoeboid movements, and then one or both have swum away. It is possible that the right combination of gametes (if they are such) has not been obtained, but as many fields of mixed spores have been watched and as germination without fusion has been seen in no less than thirty-two of these it seems unlikely that the zoospores are gametes.

[1] Sparrow (19) has described a similar phenomenon in *Monoblepharis.*

Germination. The early stages of germination have been followed in zoospores which have swarmed and germinated in pond water or soil-extract solution on a slide, while later development has been observed in these solutions only on an agar medium. Similar sporelings and young plants have been found on tomatoes collected from the ponds and from the aquaria. After two to seven days the tomato skin becomes covered with numerous colourless spots, which may be groups of sporelings, or they may be bacterial zooglea. Some days later uninucleate spores have been observed within the zooglea and a few days later again plants of *Blastocladia* have been recognized. Since heavy bacterial zooglea were not always first developed it is unlikely that they play much, if any, part in the foundation of the pustule, yet they do not appear to hinder the development of the sporelings or young plants.

Soon after the zoospore comes to rest a small protuberance, which is the beginning of the germ tube, appears from the spore. The germ tube grows rapidly, while there is little, if any, development of the main body of the spore (Fig. 2 *a–d*). Then, when the germ tube is well established, the main body of the spore enlarges and the nucleus divides (Fig. 2 *e*). From the subsequent development it is clear that this germ tube is the initial of the rhizoidal system and that the main body of the sporeling enlarges to give the primary main axis. The nuclei in this main axis divide many times while the axis elongates, lobes and begins to branch (Fig. 3 *e–p*). Although simultaneous division of the nuclei has been observed in later stages, the nuclei must at first divide independently, as sporelings frequently contain an uneven number of nuclei. Meanwhile the rhizoid elongates and widens, but it appears to branch very little or not at all, until the main axis is further established, when it must branch freely, since it is an elaborate system in mature plants.

Summary

1. *Blastocladia Pringsheimii* is shown to exhibit wide variation in habit, but no *periodicity* in either growth-form or in frequency of resting spores and "hairs".

2. The development of the sporangium with simultaneous divisions of the nuclei is described.

3. The following facts are demonstrated for the zoospore.

(*a*) The swarmers are shown to emerge in a vesicle under certain conditions.

(*b*) No fusion has been observed between the swarmers, and it is concluded that they are asexual and rightly termed zoospores.

(*c*) The zoospore germinates by a small tube, which gives rise to the primary rhizoidal system, while the main body of the spore expands into the main axis.

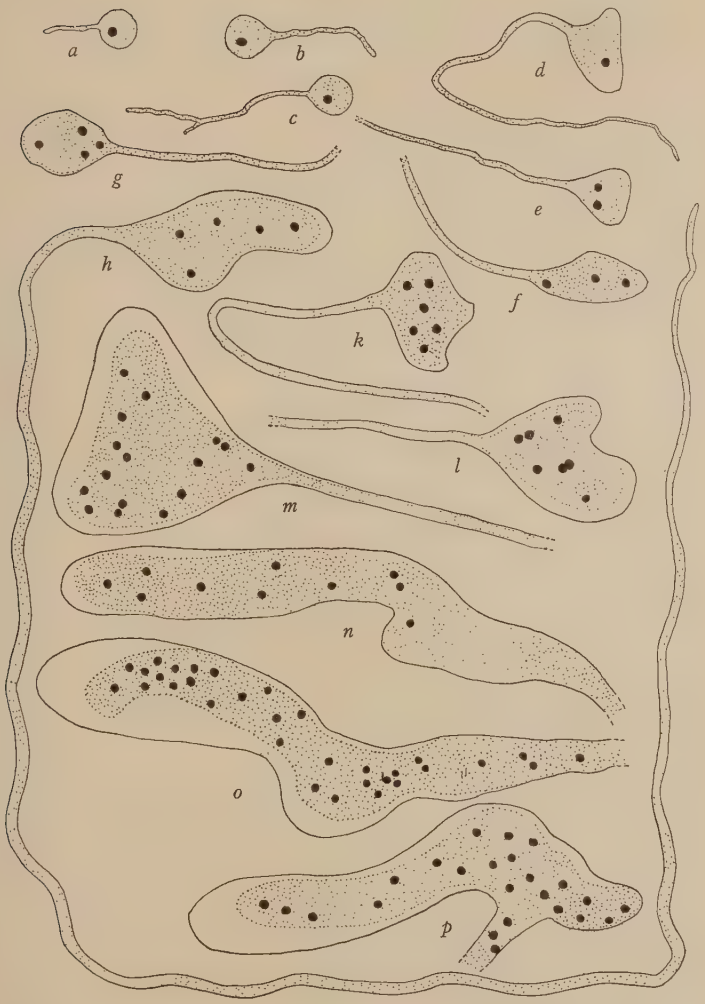

Fig. 3. Germlings (× 1000). In the older ones only the emergent part is shown the rhizoidal part being already extensively developed.

In conclusion, I should like to thank Miss E. M. Blackwell for her helpful criticism and stimulating interest throughout this research and Mrs Topping (Dr M. P. Hall) for suggesting the subject.

REFERENCES

(1) Barnes, B. & Melville, R. (1932). "Notes on British aquatic fungi." *Trans. Brit. mycol. Soc.* xvii, 82–96.
(2) Barrett, J. T. (1912). "The development of *Blastocladia strangulata*, n.sp." *Bot. Gaz.* liv, 353–70.
(3) Cook, W. R. I. & Forbes, E. J. (1933). "Investigations on aquatic fungi." *Nature, Lond.*, cxxxii, 641.
(4) Cotner, F. B. (1930). "Cytological study of the zoospores of *Blastocladia*." *Bot. Gaz.* lxxxix, 295–309.
(5) Forbes, E. J. (1935). "Observations on some British water moulds (Saprolegniales and Blastocladiales)." *Trans. Brit. mycol. Soc.* xix, 221–39.
(6) Hatch, W. R. (1933). "Sexuality of *Allomyces arbuscula*." *J. Elisha Mitchell Sci. Soc.* xlix, 163.
(7) —— (1935). "Gametogenesis in *Allomyces arbuscula*." *Ann. Bot., Lond.*, xlix, 533–49.
(8) Kanouse, B. B. (1925). "On the distribution of the water moulds, with notes on the occurrence in Michigan of members of the Leptomitaceae and Blastocladiaceae." *Mich. Acad. Sci. Arts Lett.* v, 105–13.
(9) —— (1927). "A monographic study of special groups of the water moulds. I. Blastocladiaceae. II. Leptomitaceae and Pythiomorphaceae." *Amer. J. Bot.* xiv, 287–306, 335–57.
(10) Kniep, H. (1929). "*Allomyces javanicus* n.sp. ein anisogamer Phycomycet mit Planogameten." *Ber. dtsch. bot. Ges.* xlvii, 199–212.
(11) —— (1930). "Über den Generationswechsel von *Allomyces*." *Z. Bot.* xxii, 433–41.
(12) La Cour, L. (1931). "Improvements in everyday technique in plant cytology." *J. Roy. micr. Soc.* li, 119–27.
(13) von Minden, M. (1912). "Chytridineae, Ancylisteae, Monoblepharidineae, Saprolegniineae." *Kryptogamenflora Mark Brandenburg*, v, 209–612.
(14) —— (1916). "Beiträge zur Biologie und Systematik einheimischer submerser Phycomyceten." *Mycol. Untersuch.* ii, 146–255.
(15) Petersen, H. E. (1909). "Studier over Ferskvands-Phykomyceter." *Bot. Tidsskr.* xxix, 345–429.
(16) —— (1910). "An account of Danish fresh-water Phycomycetes, with biological and systematic remarks." *Ann. Mycol.* viii, 494–560.
(17) Reinsch, P. F. (1878). "Beobachtungen über einige neue Saprolegnieae, über die Parasiten in Desmidien-Zellen, und über die Stachelkügeln in Achlyaschläuchen." *Jb. wiss. Bot.* xi, 283–312.
(18) Sparrow, F. K. (1932). "Observations of the aquatic fungi of Cold Spring Harbour." *Mycologia*, xxiv, 268–303.
(19) —— (1933). "The Monoblepharidales." *Ann. Bot., Lond.*, xlvii, 517–42.
(20) —— (1935). "Recent contributions to our knowledge of the aquatic Phycomycetes." *Biol. Rev.* x, 152–86.
(21) —— (1936). "A contribution to our knowledge of the aquatic Phycomycetes of Great Britain." *J. Linn. Soc.* l, No. 334.
(22) Thaxter, R. (1896). "New or peculiar aquatic fungi. 3. *Blastocladia*." *Bot. Gaz.* xxi, 45–52.

THE LIFE HISTORY AND MORPHOLOGY OF *DICRANOPHORA FULVA* SCHRÖT*

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(With Plates X and XI and 80 Text-figures)

This member of the Mucorales was first found by Schröter near Baden in 1877, and again in 1879, growing on *Paxillus involutus*. In 1904 it was found on *Gomphidius viscidus* in the Peloponnese and sent to Vuillemin (2), and in 1927 Ling-Young found it on *Boletus scaber* in the forests of the Puy de Dôme. In addition, an unnamed species of *Dicranophora* found by Thaxter on Boleti at Kittery Point, Maine, U.S.A., was briefly described by Blakeslee in his classic paper of 1904. These are the only recorded appearances of the fungus in nature.

The accounts are short and incomplete and differ on a number of points. Blakeslee and Ling-Young were concerned only with the sexual stage. Vuillemin, whose paper is the only one published on *Dicranophora* alone, dealt chiefly with the sporangial stage. The chief characteristics of the fungus, as described by Schröter (5), may be summarized thus: Protoplasm yellowish red. Sporangia of two types, (1) large, with conical columella, and small elliptical spores, and (2) small, with two- or three-pointed forked columella and one or two much larger reniform spores. Zygospore spherical, chestnut-brown, smooth or with fine warts, suspensors very unequal, the one swollen, the other thread-like.

Reference to Vuillemin's paper (2) shows that he regarded the supposed columella as "rudimentary branches of the apophysis, continuing the dichotomy of the axis, and having nothing to do with a columella". The saddle-shaped "apophysis" cannot be called a columella, as it does not encroach upon the interior of the sporangiole. He compares it, however, to the subsporangial swellings of *Pilobolus* and the Entomophthorales, since, he states "le redressement brusque du plancher en forme de selle a pour effet de décoller le microcyste et de le projeter avec force". Flies, he suggests, probably assist dissemination.

Schröter (1), in describing the copulating branches, states that the upper third of the thicker one is distinguished by a cross-wall for the formation of the zygospore, and remarks that their unlike character "points distinctly to a sexual difference in the branches, and suggests an antheridium and an oogonium". Blakeslee's figures ((4), Pl. I,

* Part of thesis approved for the Degree of Doctor of Philosophy in the University of London.

figs. 10–14) show the development of a "bulge" on the female hypha, in contact with the male, which gives rise to the entire gametangium, and is much more clearly demarcated from the parent branch than that shown by Ling-Young (3), who was, however, in agreement with him that "L'ampoule copulatrice du sexe femelle ne se forme que sous l'action provocatrice du gametophore mâle". Gwynne-Vaughan & Barnes (7) reprint in their textbook two of Blakeslee's figures, and state that one of the gametangia "becomes swollen, and a characteristic bulge develops on its stalk"—a point not mentioned by Blakeslee, and which seems to require further explanation. The zygospore coat is also variously described as smooth or finely warted, by Schröter, and characterized by deep crevices and resembling that of *Spinellus*, by Vuillemin.

The systematic position allotted to *Dicranophora* by Schröter (5) and adhered to in later systematic works, is next to *Thamnidium*, from which it is distinguished by the presence of a columella, and of a peculiar type of spore, in the sporangiole. Blakeslee, and Gwynne-Vaughan and Barnes, referring to the sexual stage, state that "the condition is essentially similar to that in *Zygorhynchus*", and Vuillemin, despite his denial of one of the chief differences from *Thamnidium*, considers that it is not related to that genus, but should be placed between *Sporodinia* and *Spinellus*. Finally Fitzpatrick (6), although taking into account Vuillemin's work, nevertheless places *Dicranophora* in the Thamnidiaceae, and distinguishes it from *Thamnidium* only by the claw-like branches clasping the sporangiole, and the dimorphism of the spores in the two types of sporangium, which, he states, makes the genus of unusual interest.

It is clear, therefore, that a thorough investigation of the life history and morphology of this fungus is needed.

Material and cultural methods

The strain of *Dicranophora fulva* Schröt. which I have studied was originally collected by Ling-Young and sent in 1928 to the Centraalbureau voor Schimmelcultures, Baarn, Holland, whence it was obtained in 1934. During the two years that I have successfully kept it in culture it appears not to have changed its character, although it is extremely variable, and sensitive to conditions of temperature, light and humidity.

Sensitiveness of the fungus

(1) *To temperature.*

A culture placed in an incubator at 26° C. for twenty-four hours was killed outright. Another, subjected to a day temperature of about 23° C. for a week-end (sixty hours), gave only one viable subculture out of ten attempts, and this was a sterile variant with spore-

less sporangia. The optimum temperature for growth and sporing is about 19° C. Exposure to freezing temperatures was found to have no injurious effect.

(2) *To light.*

Cultures left on the laboratory bench developed sporangia, but no zygospores. So also did those kept in the dark and examined daily. The extraordinary sensitiveness of the fungus to light was not discovered until plates left in the dark without examination for a week were found to bear a mass of zygospores, but no sporangia. It was then found that sporangia are formed only where there has been some illumination, whereas the early stages of zygospore formation occur only in the dark. A very slight exposure to light, e.g. that caused by a brief examination of the culture, is sufficient to induce sporangial formation, and to inhibit the development of the larger zygophoric branches, which lose their contents into the surrounding mycelium, and are left as empty sacs.

Although this sensitiveness to light has not been referred to by previous authors, and it is possible that it is a pathological condition associated with long culturing, there is reason to suppose that Blakeslee's material may have shown the same thing. He states that, of three stender dish cultures, "one left covered in a drawer produced abundant zygospores and few sporangia; while the other two, one of which was placed uncovered on a laboratory table, and the other in a sealed vessel with calcium chloride,... produced sporangiophores but no zygospores". He attributes this to the difference in humidity, but the result is that which would be obtained by light sensitivity, assuming that the "sealed vessel" was of glass and was kept in the light, as would be probable. The few sporangia on the covered plate could be induced by once examining it. Blakeslee also states that "under favourable conditions" sporangia and zygospores are produced on the same plate. This also is compatible with light sensitivity, since this result is obtained when, as is customary, the plates are kept in a dark incubator which is opened at intervals. Zygospores and sporangia are also obtained together on a culture grown in very diffuse daylight, which accounts for the occurrence of zygospores on the underside of the cap of an Agaric, and between the interstices of a piece of bread. Probably the night is a sufficiently long period of darkness to allow the completion of the earliest and most sensitive stages. A more detailed investigation of this phenomenon is now in progress.

(3) *To humidity.*

Differences in humidity do not appear greatly to affect the relative numbers of sporangia or zygospores. The fungus, however, is killed

by desiccation, and the older white parts of the aerial mycelium are not viable. Hence subculturing every ten days is necessary for safety. In a saturated atmosphere the sporangiophores tend to produce irregular swollen masses (e.g. Text-fig. 10), the conditions for the formation of which require further investigation. When the culture is flooded the sporangiophore initials burst, and extrude all their protoplasm as a long coil. In several cell cultures, however, in which a thin film of condensed water was formed, the swollen tips produced a number of radially arranged "buds", the whole resembling, in general arrangement, the oedocephaloid "head" of *Cunninghamella* (Pl. X, fig. 24), although differing in many details, and particularly in the fact that the "buds" do not drop off, but may germinate *in situ* as shown in the photograph. Blakeslee's *Mucor* I which "produces chlamydospores which bud in a characteristic oedocephalum-like manner"(4), probably affords a closer comparison, although in *Dicranophora* chlamydospores are never formed.

Media

In order to discover what type of medium was most suitable, I grew the fungus on a range of common media, under comparable conditions of light and temperature. The figures given in the following table are purely relative, and were assigned on an estimate of the appearance of the cultures under a low power binocular. Greater accuracy is impossible without rigid standardization of all conditions.

Medium	Mycelium	Yellow pigment	Sporangia	Zygospores
Plain agar	1	0	0	0
Glucose asparagin agar	3	0	1	0
Glucose peptone agar	5	0	2	0
Potato agar	9	4	10	2
Prune agar	10	10	10	3
Malt agar, *p*H 6	6	6	8	7
Malt agar, *p*H 7·5	7	7	7	8
Malt broth, *p*H 7·5	8	7	2	10
Brown bread	.	8	9	6

It will be seen that no zygospores, or pigment, are formed on the artificial media, and that malt agar is the best general purpose medium. 3 % malt agar, cleared and filtered for the sexual stages, was accordingly used for the bulk of the work. Difference in *p*H has no great effect, but on the whole alkalinity appears to favour zygospore production. A fairly vigorous growth is, however, obtainable on this medium from *p*H 4 to 8. Malt broth does not produce sporangia until a thick mat of mycelium has made a skin capable of bearing aerial branches.

An attempt to culture *Dicranophora* on its natural host, *Boletus scaber*, failed owing to bacterial infection, but its luxuriant growth on brown bread, with superficial sporangia, and zygospores between the folds of

the crumbs, probably resembles the natural state (see Ling-Young (3)) much more closely than do the plate cultures.

Technique of culturing

For the study of the sporangial stages Vernon's technique (8) was at first adopted, but the rapid drying which takes place on the microscope stage was a serious difficulty, and it was found more satisfactory to cut out blocks of agar, bearing mycelium from a plate culture, and put them under a cover-slip on an ordinary ring cell. Sporangiophores then begin to emerge from the agar on the second day, and grow parallel to the cover-slip, producing sporangia usually on the third day when the room temperature is fairly high (about 17° C.). The chief trouble in such a closed cell is excessive condensation, which is very liable to spoil serial observations, as may be seen from the series of photographs (Pl. X, figs. 14–23) of which the later stages are partly obliterated by a creeping film of moisture. To overcome this difficulty a type of split cell was improvised which is described in the section on the sporangial stage.

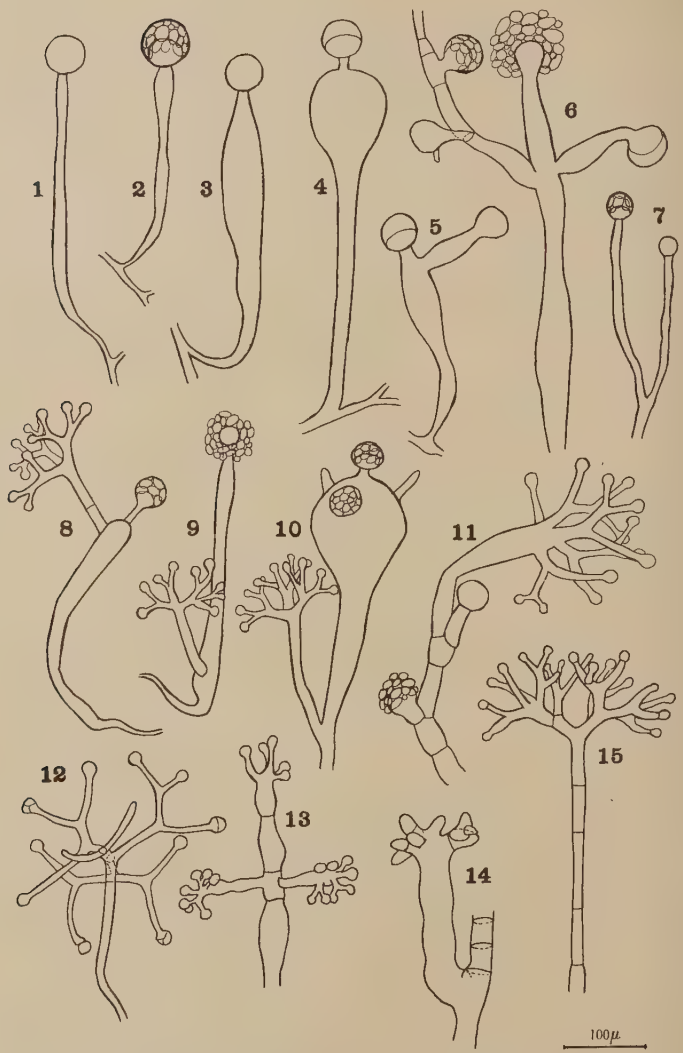
The sensitiveness of the sexual stage to light necessitated a special technique for the study of the living material. A range of light filters from ultra-violet to red was interposed on the substage of the microscope, but the sex organs always lost their contents and ceased development after the exposure necessary for a camera lucida drawing. Finally I found it possible, by using a deep red dark-room filter on the lamp, and a pale green filter on the substage, to make hurried outline sketches of the sex organs in the dim orange light resulting, without always interfering with their development. When it was necessary to focus on details the green filter was pushed aside and replaced as soon as possible. In this way the complete development from early contact to zygospore was followed on five occasions only, out of several hundred attempts. Even less success rewarded attempts to take serial photographs. Pl. XI, figs. 36, 37, are the only two successive photographs showing further development of the sexual stage. The exposures were fifteen seconds on a hypersensitive panchromatic plate, with a 60 W. bulb.

It was found necessary to design a special type of chamber which would allow examination of the sexual stage with the 1/6 in. objective without the necessity of disturbing the culture. Details of this have been published elsewhere (9).

The sporangial stage

(1) *The sporangiophore*

A culture of *Dicranophora* grown in the light exhibits a variety of sporangial forms, some of which are shown in Text-figs. 1–15. The variation in appearance is chiefly due to the sporangiophore, which



Text-figs. 1–15. *Dicranophora fulva*. Forms of the sporangiophore.

may be simple or branched, narrow or swollen. The commonest type of simple sporangiophore has the slightly swollen form shown in Text-fig. 2, but the swelling may be absent (Text-fig. 1) or much more pronounced (Text-figs. 3, 4). The large subsporangial swelling shown in Text-fig. 4 has a superficial resemblance to that of *Pilobolus*, which is increased when the short stalk between it and the sporangium is absent, as sometimes occurs. It has, however, no explosive function, and has even been pricked with a glass splinter without collapsing. Text-fig. 10 shows one such swelling which bears several sporangia, and is also putting out two branches.

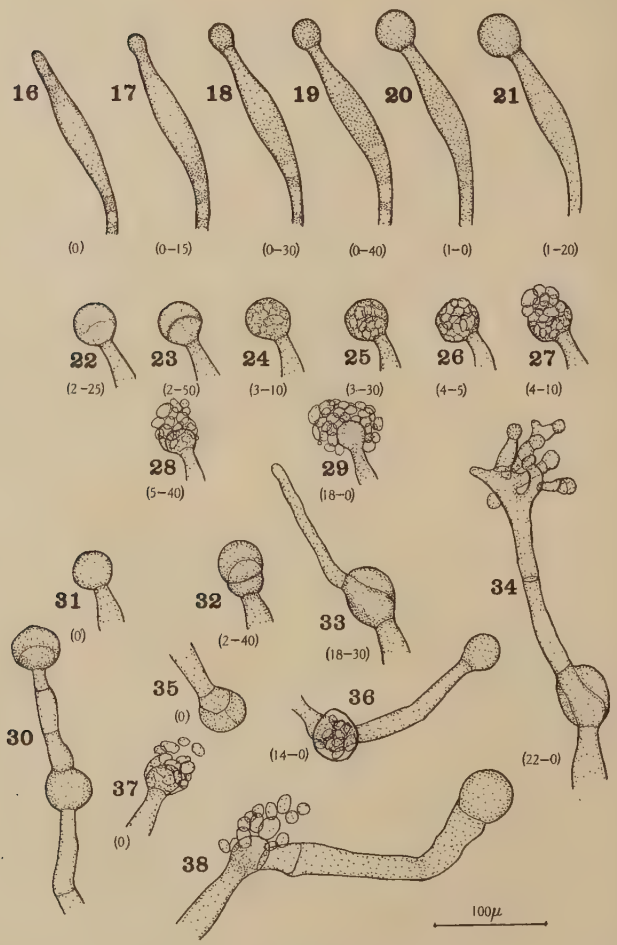
The large sporangia are most frequently borne on unbranched sporangiophores, but Text-figs. 5–7 show that slight irregular branching may occur. They may also be associated with the sporangiole branch systems (Text-figs. 8–11), but more commonly not. The main axis of the sporangiole branch system may, like the sporangiophore of the large sporangium, be thin (Text-fig. 15) or more or less swollen (Text-fig. 14); and the branching may be lax (Text-fig. 12) or dense (Text-fig. 13), varying chiefly with the light intensity. Forms intermediate in size and in appearance between the typical sporangiophore and sporangiole branch system, are sometimes to be found (e.g. Text-fig. 7).

(2) *The sporangium*

Text-figs. 16–29 illustrate, by a series of camera-lucida drawings, the development of a single sporangium. In the early stages dense granular protoplasm is visibly flowing in at a rapid rate, and pressing up the club-shaped sporangiophore in the form of dense "plugs" which tend to coalesce towards the tip. A wide area of mycelium is thus drained of protoplasm in a short time, the highest rate of flow measured being 115 μ in ten seconds. The tip swells to the full size of the spherical sporangium in about an hour, and a back flow of protoplasm down the sporangiophore has been seen after the maximum size has been attained.

The dense protoplasm which packs the swelling tip usually ends in an irregular line visible just below the line of demarcation between the curved surface of the sporangium and the cylindrical sporangiophore. A septum has not been seen in this position, nor in the position figured by Schröter ((5), Fig. 113B) a little farther down the stalk, although septa are sometimes found in the branched sporangiophores.

A delay of about one hour occurs between the attainment of full size and the first appearance of the columella as a faint division across the sporangium (Text-fig. 22). For a short period the columella boundary is visible as a clear zone often appearing nearer the top of the sporangium, and apparently, owing to the effects of refraction by the curved surface, extending to the sides rather than the base



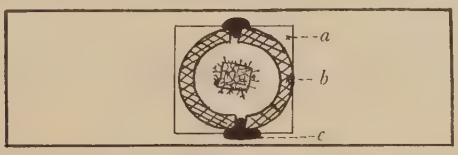
Text-figs. 16–29. *Dicranophora fulva*. Stages in the development of a single sporangium.
Text-fig. 30. Branch produced from a young sporangial swelling.
Text-figs. 31–4, 35–6, 37–8. Three different series showing sprouting of the columella.

The numbers in brackets show the times, in hours and minutes, from the previous figure marked (0).

(Pl. X, fig. 4); this boundary, however, becomes indistinct at the onset of spore formation and remains so until the spores are fully formed. The particular sporangium shown in Text-figs. 16–29 burst in contact with the cover-slip after about four hours, the spores flowing out to form a patch, for the most part in the plane of the cover-slip, around the columella (Text-fig. 29 and Pl. X, fig. 8).

When the sporangium does not touch the glass, it gives place to a large water drop which contains the spores (Text-fig. 2 and Pl. X, fig. 2). This may be compared with the oidial drops of *Coprinus* described by Brodie(10). The thin smooth hyaline membrane is invisible, except in mounted material, and it is impossible by direct observation to determine exactly when the sporangial wall bursts and is replaced by the water surface, but if the drop is allowed to dry, it is possible to see whether it keeps its shape or resolves itself into a mass of spores.

For this purpose a type of cell (shown in plan in Text-fig. 39) was improvised, in which it is possible to control the rate of drying of the



Text-fig. 39. Plan diagram of a type of split ring cell used for observations on sporangia. *a*, square cover-slip; *b*, split glass ring; *c*, wax plug.

contents to some extent. A small block of agar cut from a plate culture is placed under a cover-slip which is vaselined to the split glass ring. The gaps in the ring are at first blocked with wax, but when the sporangial drops have appeared the humidity is lowered by removing some of the wax and allowing the water vapour to escape. By watching a number of marked sporangia it was possible to determine that no membrane was present in most of the "sporangial drops", since they dried down into irregular spore masses. In three, however, out of twenty observed, the membrane was still present. One of these was seen to contract from 50 to 38 μ in diameter in two hours—a loss of about 50 % of its volume, and 42 % of the surface area of the membrane, which must therefore be extremely elastic. On two cultures on an old malt agar, the sporangial membrane, which elsewhere was invariably quite smooth and hyaline, was covered with crystals, probably of calcium oxalate, since they did not dissolve in dilute mineral acid (see Pl. X, fig. 11).

A sporangium, or at least a terminal swelling entirely similar to a young sporangium, may give rise to a hypha without further develop-

ment (Text-fig. 30). On the other hand, the columella may sprout before or after spore formation. The sporangium shown in the series Text-figs. 31–34 gave rise in two and a half hours to the remarkable two-celled form shown in Text-fig. 32, in which, apparently, the sporangial cavity encloses only the top half of the columella. The lower cell gave rise overnight to a branch which emerged near the top of the upper cell (Text-fig. 33) and produced a bunch of sporangioles in a few hours. Such two-celled forms have been observed a number of times, and may sprout from either cell, though more commonly the basal one. The distal cell has only once been seen to form spores.

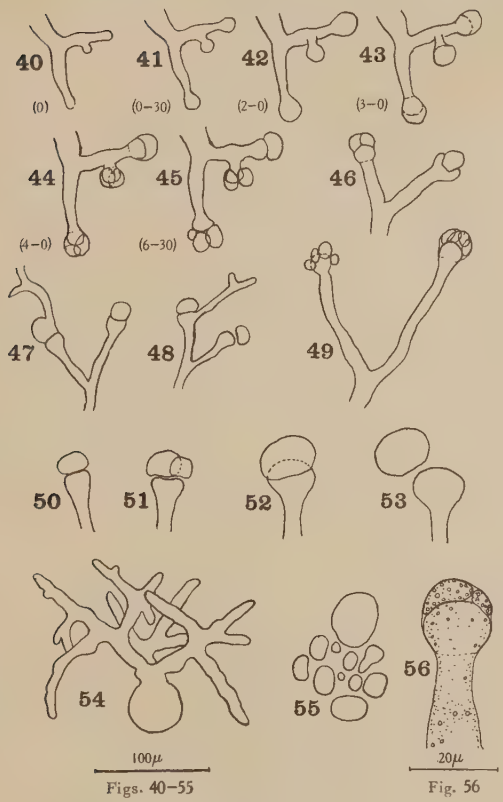
Sprouting of the columella after spore formation is shown in Text-figs. 35, 36, where the branch has pushed aside the sporangial sac in which spores have nevertheless been formed, and in Text-figs. 37, 38, in which the sporangium has burst before the appearance of the branch. Pl. X, fig. 13 is a photograph of the same object as Text-fig. 38, taken a little later. The columella now appears merely as a "knee" in the sporangiophore, but can be distinguished by the patch of spores beside it.

From the figures (particularly Pl. X, fig. 2) it will be seen that the wall of the columella is more or less spherical. The range of variation is very small—from a slightly depressed to a slightly raised oval.

(3) *The sporangiole*

The development of the sporangiole shows the same stages, and takes about the same time, as that of the sporangium, and it is sufficiently illustrated by Text-figs. 40–45, Pl. X, figs. 3–5 and figs. 14–23. The young sporangiole is more or less globose, although later the membrane adapts its shape to that of the spores beneath, so that it is often two- or three-lobed (Text-fig. 46). The columella is not easily seen owing to the thinness of the scarcely visible membrane which is pressed tightly to it except where separated from it by the spores. Text-fig. 56 and Pl. X, fig. 9, however, place this point beyond doubt. The columella can be clearly demonstrated when sporangioles are mounted in water and gently crushed under the cover-slip. In a small proportion of those which remain unburst, the sporangial membrane separates from the columella and spores (as shown in Pl. X, fig. 9).

The columella is of the same shape as in the large sporangium, namely, a slightly depressed oval, although in mounted material it is frequently distorted. It has the same ability to branch, and "two-celled" forms have also occasionally been seen (Text-fig. 47). On the other hand, the object shown on the right of Text-fig. 46 is the only approach seen to the "tong-like claws" reported in this genus.



Figs. 40–55 Fig. 56

Text-figs. 40–5. *Dicranophora fulva*. Stages in the development of a small part of a sporangiole branch system.
Text-fig. 46. "Lobed" sporangiole and (right) claw-like outgrowths of columella.
Text-fig. 47. "Two-celled" sporangioles, showing sprouting of distal cell (left).
Text-fig. 48. Sprouting columella of sporangiole.
Text-fig. 49. Small "intermediate" sporangia.
Text-figs. 50–1. Large sporangiole-like forms (after disappearance of the membrane).
Text-figs. 52–4. The liberation and germination of a "giant" spore.
Text-fig. 55. Group of spores showing variation in size.
Text-fig. 56. Sporangiole in section, showing columella, two spores and membrane. Camera lucida drawing under 1/12 in. objective.

The numbers in brackets show the times, in hours and minutes, from the previous figure marked (0).

This was found in a culture grown on bread. The columella is concave, and clasps the single spore, but the effect is probably exaggerated by mounting in water.

(4) *The spores*

In point of size and spore number, some of the largest sporangioles are indistinguishable from small sporangia (e.g. Text-fig. 49). A count of the spore numbers in five hundred burst sporangioles in mounted material gave the following frequencies:

Spore numbers	1	2	3	4	5	6	7	Over 7
Frequencies	264	156	64	13	1	1	1	0

For this purpose any spore-bearing body borne on a dichotomous branch system was reckoned a "sporangiole". On the other hand, three out of a hundred "sporangia" borne on simple sporangiophores were found to have less than ten spores (e.g. Pl. X, fig. 7), and forms borne on very lax branch systems (Text-fig. 7) were quite impossible to distinguish as one or the other. Very large "sporangioles" with one or two spores only (Text-figs. 50, 51) provide further links, and the discovery of large one-spored sporangia completes the evidence as to the continuity of the two forms.

The range of spore size in sporangia is extremely wide, normally from 5 to 30 μ, but I was surprised to find in some spore mounts "giant" spores 40–50 μ in diameter, i.e. the full size of an average sporangium. The problem was solved by chance manipulation of a "two-celled form" in which the distal "cell" was detached with a glass splinter (Text-figs. 52, 53) and transferred to a malt-agar slide, where it germinated as shown in Text-fig. 54. Some difficulty was found in pulling the giant spore away, for it sprang back to the columella several times under the pull of the elastic membrane, which was invisible under the low power used. A similar giant spore (not quite so large—about 30 μ in diameter) is shown standing on a flattened columella in Pl. X, fig. 6. This, however, despite its size, was borne on a lax dichotomous branch system.

It is evident, therefore, from the foregoing observations, that the distinction between sporangium and sporangiole is quite an arbitrary one, and the typical sporangiole does not differ from the sporangium, except in size, spore number, and position on a branchlet farther from the protoplasmic stream of the main axis, which would account for the other differences.

The alleged dimorphism of the spores in the two sorts of sporangia is sufficiently disproved by the average dimensions given below, which are based upon measurements of two hundred spores from each sort,

arranged in frequency classes of 1 μ. The corresponding figures for *Mucor hiemalis* are given for comparison.

	Length	Breadth	Ratio length to breadth
Dicranophora, sporangium spores	Mean 13·46 $\mu \pm$ 0·82 Range 5–30 μ	Mean 10·83 $\mu \pm$ 0·77 Range 3–25 μ	1·24
Dicranophora, sporangiole spores	Mean 12·95 $\mu \pm$ 0·68 Range 5–20 μ	Mean 9·23 $\mu \pm$ 0·65 Range 3–20 μ	1·40
Mucor hiemalis	Mean 5·40 $\mu \pm$ 0·42 Range 3–8 μ	Mean 3·40 $\mu \pm$ 0·34 Range 2–6 μ	1·59

It is clear from these figures that the spores in the sporangioles are not larger than those in the sporangia, and, in fact, appear to be slightly smaller, although the differences between the mean dimensions are not significant.

The comparison with *Mucor hiemalis* serves to emphasize the extraordinarily wide range in spore size of *Dicranophora* (see Text-fig. 55 and Pl. X, fig. 7). Spores at the top of the normal range ($25 \times 30\,\mu$) are as much as 417 times the volume of the smallest spores ($3 \times 5\,\mu$). In a single sporangium chosen at random the largest spore ($14 \times 18\,\mu$) was found to be seventy-eight times the volume of the smallest ($3 \times 5\,\mu$). In contrast, the largest spore of *Mucor hiemalis* was found to be less than twenty-two times the volume of the smallest, and in a single sporangium, about seven times. It seems probable that, in regard to spore size, *Dicranophora* is by far the most variable of the Mucorales.

The absence of the largest spores from the sporangioles, as indicated by a smaller range, is responsible for the lower mean of the sporangiole spores, and the fact that only typical sporangia and sporangioles were chosen for these measurements would tend to this result, by excluding forms which might be regarded as large sporangioles or small sporangia, and might be expected to contain spores of corresponding size.

The slightly greater ratio of length to breadth in sporangiole spores, corresponds with a higher proportion of long narrow spores in the sporangioles, in which the spores are necessarily compressed between the membrane and the columella (Text-fig. 56), and consequently tend to have a convex outer, and a concave inner surface, thus assuming a kidney shape which is most obvious where there is only one spore in the sporangiole. When liberated, however, they round off to an elliptical shape. Similar, but less obvious, compressed spores are found among the sporangiospores, and it is therefore clear that the spores in the sporangioles differ from those in the sporangia only in the slightly more compressed shape imposed upon them by the limited curved boundaries of the sporangiole.

(5) *The "sporangial unit"*

The fact that the young sporangiophore, before it swells at the tip, is indistinguishable from the sporangiole branch system initial, before it has started to dichotomize, suggests that the organs produced by them are homologous. An attempt was therefore made to compare the numbers of spores produced by the large sporangium and the sporangiole branch system, respectively.

The number of spores in a sporangium may be fairly easily counted when the sporangium bursts against the cover-slip, forming a patch of spores about one deep, held together by the surface tension of the water (Pl. X, fig. 8). It is possible to exclude spore patches which are incomplete, or have received spores from other sporangia, and for the purpose of the count only sporangia on an unbranched stalk were included. In this way a count was made of the spore numbers in a hundred sporangia, chosen at random from twelve different cultures in ring cells.

It was impossible, however, to count directly the number of spores in a sporangiole branch system. The sporangioles therefore were counted, on a hundred branch systems on the same twelve cultures, and their number multiplied by a mean obtained by counting the number of spores on two hundred burst sporangioles in the same material.

The results obtained from these counts were as follows:

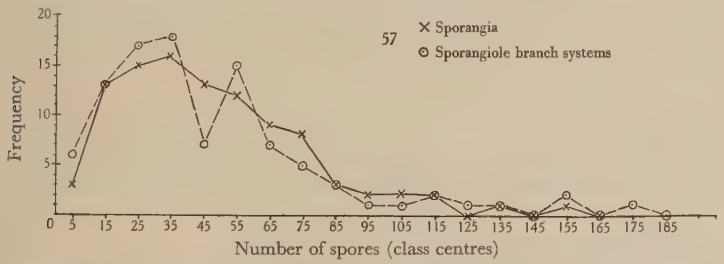
Spore numbers in	Range	Mean	S.E.
Sporangia	5–160	47·5	6·82
Sporangiole branch systems	4–180	46·8	? Large

The closeness of the means is of little significance in view of the large unknown error introduced with the additional estimate involved in the second mean. On the other hand, the great similarity of range and form of the two frequency curves (Text-fig. 57) cannot be put down to chance, and it seems evident that the initial club-shaped branch gives rise to a "sporangial unit" which, whether it forms one sporangium, or many sporangioles, contains the same amount of protoplasm, and produces about the same number of spores. The factors which determine whether the tip will swell, or branch, remain to be discovered, but there are indications that light is the most important.

(6) *Comparison with previous accounts*

The foregoing description differs most obviously from that of Schröter(5), both regarding spore size, and the conclusion that the two types of sporangium are not essentially different. Schröter describes the sporangiospores as: "etwa 7–14 μ lang, 4–10 μ breit

(meist $7\mu \times 5\mu$)" and the spores in sporangioles as "gross, nierenformig, 22–26μ lang, 11–15μ breit". Not only are these figures in disagreement with mine as regards dimorphism, but it is clear, also, that the variation in spore size, which was remarked upon by Schröter, is even more pronounced than he thought. The difference in shape of the columella, which in my material varies very little from its spherical shape, and never approaches the conical, is probably of less significance, in view of Vuillemin's statement that it may also be pyriform or hemispherical. It would seem, however, that the process of culturing to which my material has been subjected has selected a strain which is very constant for this factor.



Text-fig. 57. *Dicranophora fulva.* Graph showing the frequency of spore-numbers in one hundred sporangia, and in one hundred sporangiole branch systems, the former being counted directly, the latter arrived at by counting the number of sporangioles per branch system, and multiplying by a mean spore-number obtained from a count of two hundred sporangioles in the same material.

The confirmation of the presence of a columella in the sporangiole necessarily conflicts with Vuillemin's view, but his interpretation of the "claws" as branches continuing the dichotomy of the axis is supported to some extent by my observations on the branching of the columella, although it cannot be fully confirmed, owing to the absence of these claw-like outgrowths (except for one isolated record) from my material. In view of the fact that Vuillemin saw no living specimens, and thought that the sporangioles themselves could be shed, or even shot off, it seems probable that he missed seeing the very inconspicuous sporangial membrane, and, sometimes at least, mistook the spore for the sporangiole.

The sexual stage

(1) *Early stages in conjugation*

The difficulty of studying the earliest stages of conjugation in *Dicranophora* has been remarked upon by Blakeslee (4). An attempt to reconstruct the process from fixed material led to quite erroneous conclusions, and despite the light sensitivity it was found necessary to make a developmental study of the living sex organs.

My observations are best described by reference to the drawings in Text-figs. 58–80, and the photographs on Pl. XI. The female sex organs arise as swollen sacs, 60 μ or more broad, which may be single (Pl. XI, fig. 27) or in groups (Pl. XI, fig. 25) and are densely packed with yellow protoplasm. These may form zygospores at once, or grow indefinitely to form a long, lobed hypha, constricted at intervals, and often branching dichotomously (Pl. XI, fig. 26). The method of growth is peculiar, and is illustrated in Text-figs. 58–61. The end of the sac becomes smoothly rounded, with a clearer border, and then puts out a protuberance, or sometimes two, which swells to about the diameter of the parent sac before behaving similarly. Zygospores are formed on the branch wherever male hyphae come in contact with it, but if unfertilized the swollen lobes may give rise to hyphae of normal dimensions recognizable by the wavy course which they take through the medium (Text-fig. 61).

Most of the female sacs form zygospores in the first stage, before any further growth occurs, or else lose their contents to neighbouring lobes on which zygospores are being formed (Text-figs. 74, 75). The series Text-figs. 62–5 shows the development of a group of three sac-like branches (Text-fig. 62*a*, *b*, *c*) which, however, did not reach maturity owing to the illumination necessary for the drawings. The lobe *b* was already producing a bulge before contact with a male hypha caused it to swell out laterally to form the female gametangium.

Legends to Text-figs. 58–80.

Text-figs. 58–80. *Dicranophora fulva.* Stages in zygospore formation.

Text-figs. 58–61. Series showing dichotomous growth of a zygophoric branch.

Text-figs. 62–5. Series showing fertilization of three female sacs at different stages of growth.

Text-figs. 66–7. Formation of a zygospore without any outgrowth of the female organ towards the male.

Text-figs. 68–9. Formation of a zygospore on a large curved branch, resembling the type of reproduction in *Zygorhynchus*. The zygospore shown in Text-fig. 69 (as also in Text-fig. 65 and one of those in Text-fig. 67) has not reached maturity owing to the effects of light, and the large gametangium has become empty, except for a mass of protoplasm which blocks the pore in the large septum.

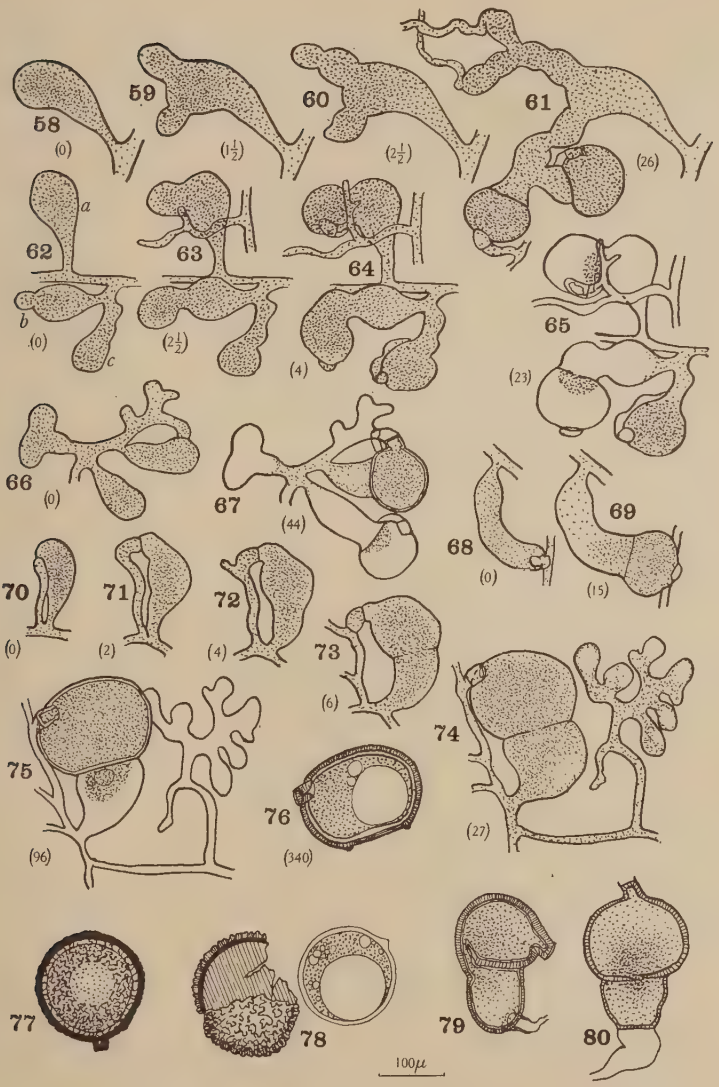
Text-figs. 70–6. Developments of a zygospore with formation of a papilla on the female sac, followed by swelling of the whole organ. The "clear stage" of the male gametangium, which precedes the thickening of the wall, is shown in Text-fig. 74, and the emptying of neighbouring unfertilized lobes in Text-figs. 74 and 75. Text-fig. 75 also shows a mass of oil and granular matter left behind in the large suspensor, and the mature zygospore, a fortnight old, with double wall, large oil drop, and "antheridial boss" is shown in side view in Text-fig. 76.

Text-fig. 77. Mature zygospore, seen from the direction of the large suspensor, the position of which is indicated by the unmarked patch on the creviced wall.

Text-fig. 78. Mature zygospore, crushed to separate the creviced exospore from the thick hyaline endospore. The slight projection on the inner coat fits into the "boss" on the outer one.

Text-figs. 79, 80. Two abnormal zygospores in which the septum cutting off the large gametangium is incomplete. In that shown in Text-fig. 79 the wall of the whole female branch is thickened. In the other (Text-fig. 80) the thickening is limited by a second septum across the branch.

The numbers in brackets show the time in hours from the previous figure marked (0).



Text-figs. 58–80 (for legends see previous page).

A similar bulge on lobe *a*, however, appears to have itself formed the gametangium, while the lobe *c* continued, after contact with the male, to swell at the tip, and would presumably, if left in the dark, have formed a zygospore without any outgrowth towards the male, as in fact was observed elsewhere (Text-figs. 66, 67).

Before contact, the male hypha is not differentiated from the other hyphae of the mycelium, and is impossible to distinguish as such; moreover, the light sensitivity prevents direct observation of the growth of the hyphae, but it is evident from Text-figs. 58–65 that the male and female branches are not always in contact from their inception, and it is difficult to interpret figs. 28 and 36 on Pl. XI as anything but early stages in contact.

The rate of linear growth of the male branch appears to be much greater than that of the female, which is to be expected from its smaller diameter. The frequent sharp bending of the male towards the female branch (Pl. XI, figs. 28, 32) suggests some chemotropic influence, which would naturally show its effect more on the faster growing hypha. Sometimes, however, the larger branch in its growth comes against the side of a narrow hypha which puts out a male progametangium at the point of contact (Text-figs. 68, 69). Here the chemotropic effect, if any, must be shown by the female. The figures show (e.g. Pl. XI, figs. 32, 35) that the male branch frequently arises near the base of the female, but may also come from an entirely different hypha.

The type of development shown in Text-figs. 70–6 appears to be the commonest, and resembles more closely that figured and described by Ling-Young. Here the papilla on the large sac is formed in response to contact with the small hypha, but the whole female branch then swells enormously, and the gametangium does not arise from the papilla alone. Pl. XI, figs. 29, 30, show early stages in contact, with a papilla on the female. Pl. XI, fig. 36, shows a very early stage in contact, and Pl. XI, fig. 37, shows the same object the next morning. Although partly obscured by shadows of hyphae and drops which have appeared during the interval, it shows clearly the swelling up of the tip of the male hypha, the passage of granular protoplasm into the tip, and its close application to the female sac, which has swelled out considerably towards the male.

(2) *The passage of contents*

The septum cutting off the male gametangium appears before that on the female. The larger septum of the latter grows in slowly towards the centre, and it is impossible to know by direct observation when it is complete, but the light sensitivity of the fungus can be used to obtain evidence on this point.

When developing zygospores are illuminated, the granular contents flow out of those gametangia which have incomplete walls, and the extent of the pore can be observed in the empty sacs. Where the pore in the large septum is small it is usually blocked by a mass of protoplasm which remains behind (Text-figs. 65, 67). A number of male gametangia in which the basal septum was complete were seen to empty themselves through the female, and actual movement of granules from one to the other was twice followed. The pore, which is at first an irregular oblong slit, can sometimes be seen when the organs are empty. Evidence of this passage of contents from the male to the emptying female gametangium is provided by the series of photographs (Pl. XI, figs. 38–40).

That passage of contents also occurs under normal conditions can be deduced from the appearance of a clear stage in the development of the male gametangium (Text-fig. 74 and Pl. XI, fig. 32), and is placed beyond doubt by the complete obliteration of its lumen by the developing wall of the zygospore (Pl. XI, fig. 42).

(3) *The zygospore*

During the period of swelling a rapid flow of protoplasm into the growing spore is visible along the neighbouring hyphae. This reverses its direction when the septum cutting off the gametangium is complete, and the large suspensor is emptied back into the mycelium, although a mass of granular matter and oil, which eventually disappears, is frequently left behind (Text-fig. 75). In this way practically the whole content of a culture kept in the dark is incorporated in the zygospores, which tend to vary in size according to the density of the mycelium. Thus, measurements of a hundred in side view (i.e. as in Text-fig. 76) from two different media, gave the following figures:

Medium	Mycelium	Zygospores per unit field (average of 10 counts)	Mean long axis	Mean short axis	Ratio length/ breadth
3% malt agar	Dense	44·1	$162{\cdot}7\mu \pm 6{\cdot}0$	$133{\cdot}9\mu \pm 5{\cdot}7$	1·215
Weak cherry agar	Less dense	47·3	$141{\cdot}9\mu \pm 5{\cdot}1$	$116{\cdot}8\mu \pm 5{\cdot}1$	1·215

The size differences are significant. The volume of a zygospore of average dimensions on malt agar is about 0·0018 c.mm.—sufficient to absorb the contents of about 23 mm. of hyphae.

It is clear from these measurements, and from Text-fig. 76 and Pl. XI, fig. 42, that the zygospore is not spherical, but is somewhat flattened on the side of the large suspensor, and is, in fact, rather the shape of a horse-chestnut seed. The outer coat is deeply and irregularly creviced (Pl. XI, fig. 43) except for a patch in the position of the

large septum (Text-fig. 77). The thick hyaline inner coat is easily separated from the outer by crushing (Pl. XI, fig. 44) and bears a small beak (Text-fig. 78) fitting into the boss on the outer wall which is all that remains of the male gametangium (Pl. XI, fig. 42). One or more very large oil drops and much granular material are always visible in the interior.

All attempts to obtain germination have failed, although zygospores have been set up under many conditions, and about two hundred have been kept for over two years. Light, darkness, heat, freezing, dissolving the walls with acid, squeezing off the outer coat, and weak and strong liquid and solid media have been tried without success.

(4) *Abnormal zygospores*

The suspensor of the large gametangium frequently exhibits one or more incomplete annular septa, similar to that which cuts off the gametangium (Pl. XI, fig. 35). In the abnormal zygospore shown in Text-fig. 80, such a septum forms the boundary of the spore, and it is to be presumed that the second septum becomes complete before the first. More often the whole female sac becomes thick-walled (Text-fig. 79, and Pl. XI, fig. 45). Up to 2 % of these zygospores occur in some cultures, and so far as can be seen, the first gametangium wall is never complete, and the outer walls are always thinner than in the normal zygospore. Such abnormal zygospores appear to be unique in the Mucorales. The only forms which resemble them are the thick-walled spores described by Chesters (11) in his recently discovered *Azygozygum chlamydosporum*. These, which he interprets as imperfect zygospores, have, however, a different origin, as they consist of the two gametangia pressed together, with or without perforations in the wall between them.

I have seen no azygospores, nor chlamydospores, in any of the cultures of *Dicranophora* grown over a period of two years.

(5) *Comparison with previous accounts*

I am in disagreement with the following statements made by previous authors:

That the large gametangium always arises from an outgrowth formed in response to contact with the male hypha (Blakeslee and Ling-Young).

That the two gametangia are completely isolated before the wall between them breaks down (Ling-Young).

That the zygospore is spherical (so described by Schröter and not denied by the others).

In addition the suspensors have been observed to branch, but not to give rise to sex organs, as reported by Ling-Young.

The fact that the sexual branches are not necessarily in contact from the first is implied by Ling-Young's reference to "l'action provocatrice du gamétophore mâle, qui évolue plus rapidement", but is nowhere stated or illustrated by his figures. In this respect *Dicranophora* alone of the Zygomycetes appears to resemble *Phycomyces nitens* as described by Burgeff(12).

The "characteristic bulge" which "develops" on the stalk of the larger gametangium, as described by Gwynne-Vaughan and Barnes, is almost certainly an unfertilized female lobe. Where, as frequently happens, only one of a group of female sacs is fertilized, the others appear to be outgrowths from its stalk; sometimes, however, the fertilized sac is itself lobed or branched at the base; but in either case the bulge is present before the gametangium is formed.

The "smoothness" attributed to the zygospore by Schröter is probably, as suggested by Vuillemin, due to his having examined young zygospores on which the thin gametangial membrane was still present.

Discussion

(1) *Sexuality*

Dicranophora possesses a character which is unique in the Mucorales, namely, the large female organ, which is clearly recognizable whether it is fertilized or not. The size difference between the gametangia is invariable, the female sac being never less than three times the diameter of the male.

Heterogamy is a much commoner phenomenon in the Mucorales than was previously thought, but the size differences reported in many genera, e.g. *Rhizopus* (Blakeslee(13)), *Sporodinia* (Moreau(14)), and *Mucor hiemalis* and *Absidia glauca* (Ling-Young(3), p. 493), are all very variable, and are regarded as having a nutritional rather than a sexual significance. A few species only are reputed to show pronounced and constant heterogamy, viz. *Dicranophora fulva*, *Zygorhynchus* (several species), *Absidia spinosa*, and species of *Syncephalis* (especially *S. nodosa*).

Of these, Green(15) has shown that in *Zygorhynchus* the size difference is far from constant, and may even be reversed. My observations on *Absidia spinosa* show that here also the relative sizes are very variable, the only constant difference being the growth of appendages on one suspensor only. The fact, referred to in a recent paper by Dodge(16), that when *Zygorhynchus* and *Absidia spinosa* are grown together "large cell reacts with large cell, small with small" indicates that in these forms the inconstant size difference does not correspond with any functional sex difference. On the other hand, in *Syncephalis* (Thaxter(17)) where the functional difference is marked, the heterogamy does not consist in a size difference, but the sex organs resemble those of the

Plectomycetes, and are entirely different from those of *Dicranophora*, which appears to be the only member of the Mucorales in which a constant size difference is established. The appearance of the young sexual branches in *Dicranophora* (e.g. Pl. XI, fig. 28) immediately suggests an antheridium and oogonium, and makes a comparison with the sexual stage of the Oomycetes inevitable.

Points of similarity are as follows:

(1) The female organ may have an independent existence apart from sexual contact.

(2) The female organ is clearly distinguishable from the male in size and shape, and contains a very large amount of reserve material.

(3) The whole contents of the male are discharged into the female sac.

(4) The protoplast of the zygote is entirely contained within the female organ.

These differences are clearly sexual, in the narrow sense of the term employed by Blackman (18), although the observation of Ling-Young, which I have been unable to confirm, that in *Dicranophora* both large and small gametangia can give rise to hyphae bearing both types of sex organ, indicates that there is here no segregation of nuclei of opposite sexes. *Dicranophora*, however, is the only Zygomycete which shows pronounced and invariable oogamy, and the similarity of its sexual stage to that of such an Oomycete as *Albugo Bliti*, in which multiple fusion takes place, can scarcely be ignored. It possesses, nevertheless, the characteristics of a very specialized Zygomycete, and even the sexual stage differs from that of the Oomycetes in the following important points:

(1) The female branch in *Dicranophora* is capable of indefinite growth and reversion to the vegetative state.

(2) The "antheridium" is included in the zygote as a small boss on the zygospore wall.

(3) The "oogonium" is not completely isolated until after the entry of the contents of the "antheridium".

(4) The nuclear phenomena of the sexual stage, as reported by Ling-Young (3), are essentially similar to those of a homogamic Zygomycete such as *Sporodinia grandis*.

(2) *Systematic position*

The wide range of forms shown by *Dicranophora*, each bearing some resemblance to a form shown by another genus of the Mucorales, is one of the peculiarities of the fungus. Instances are the *Pilobolus*-like swellings, and oedocephaloid heads occasionally produced on the sporangial stage, but a comparison with the four genera to which it shows the greatest resemblances is most concisely shown by a table:

Comparison of other Mucorales with Dicranophora fulva

Genus	Similarities	Differences
Thamnidium	Large and small sporangia, the latter on dichotomous branch systems; apparently homothallic.	No pigment, sporangioles without columella, shed as conidia. Zygospores homogamic where known, in scalariform series on erect filaments. Usually coprophilous.
Zygorhynchus	Homothallic, usually markedly heterogamic. Copulation by large curved branch commonly occurs as in *Dicranophora* (Text-fig. 69). Zygospores non-aerial.	No pigment. Sporangia dissimilar. Heterogamy variable. Copulation unlike that usual in *Dicranophora*. Zygospores dissimilar. Not epiphytic.
Sporodinia	Coarse hyphae with granular pigmented contents. Sporangia on dichotomous branch systems. Homothallic, occasionally heterogamic. Zygophores also dichotomous. Parasitic on wide range of Agarics and Boleti.	No sporangioles. Gametangia normally about equal, and copulating branches straight. Zygophores aerial.
Spinellus	Pigmented hyphae. Spindle-shaped sporangiophore. Homothallic. Occasionally heterogamic (*S. chalybeus*). "Tong-like" copulation. Creviced zygospore coat. Parasitic, each species restricted to one species of Agaric.	"Thorny" hyphae. No sporangioles. No prominent dichotomous branch systems. Normally homogamic. Zygospores aerial.

A consideration of the facts summarized in the table leads inevitably to the support of Vuillemin's view, that *Dicranophora* should be classified with *Sporodinia* and *Spinellus*. My investigation has, I think, shown that Vuillemin was wrong in supposing that the sporangioles lacked a columella, and could be shed, like those of *Thamnidium*, and it is clear that they are quite comparable with the sporangia of *Sporodinia*, except in size and spore number. With regard to its range of host also, *Dicranophora* seems to be intermediate between *Sporodinia* and *Spinellus*, since it seems to be confined to Boleti and the lower Agarics, although the number of times it has been found is too small to make this assumption reliable.

In any phylogenetic series, it is convenient to regard this group of homothallic Mucorales (*Dicranophora*, *Sporodinia*, and *Spinellus*) as linked to some extent to the Oomycetes, through the oogamy of *Dicranophora*, the Cephalidaceae (especially *Syncephalis*) being regarded in a similar way as a link with the Ascomycetes. This, of course, is not a suggestion that *Dicranophora* is either derived from, or has given rise to, any Oomycete, which, in view of its specialized habitat and asexual characters, is highly improbable; but our objective knowledge of the phylogeny of the Phycomycetes is so negligible, that the chief justification for any such phylogenetic arrangement, based upon comparative morphology, seems to me to lie in its value as a mnemonic for the characters of the fungi.

Summary

1. *Dicranophora fulva* grows readily in culture, but forms no zygospores on purely artificial media. It is extremely sensitive to light, forming sporangia only when illuminated, and zygospores only in the dark, or in very diffuse daylight.

2. In the material studied, the columella in the large sporangium is rounded, not conical. There is a columella in the sporangiole, but the claw-like outgrowths described by previous authors have been observed only once. The columella in both large and small sporangia has, however, been seen to produce a hypha.

3. The reported dimorphism of the spores in the two sorts of sporangia does not exist, except in so far as the spores in the sporangiole are somewhat more compressed. The liberation of the contents of a large sporangium as a single giant spore is described. The range of spore size appears to be far greater than in any other Mucorales.

4. The sporangiole differs from the sporangium only in its size and position on a dichotomous branch system. Intermediate forms occur which are not distinguishable as one or the other.

5. The sporangiophore appears to give rise to about the same number of spores, whether it bears one large sporangium, or forms a branch system bearing many sporangioles.

6. *Dicranophora* is the only Zygomycete in which a constant size difference between the gametangia has been shown. It is unique in possessing a female organ which may have an independent existence apart from sexual contact, and it differs from most of the Mucorales in that the sexual branches grow into contact, and are not necessarily in contact from the first.

7. The extent to which the female branch produces an outgrowth towards the male is very variable. The wall between the gametangia breaks down before the larger one is completely isolated, and the whole contents of the male pass into the female gametangium, in which the zygospore is formed.

8. The zygospore is not spherical, but slightly flattened on one side, with a deeply creviced outer coat, and a small boss representing the male gametangium. It has not been germinated. Some abnormal zygospores are described.

9. Support is given to the view that *Dicranophora* should be classified with *Sporodinia* and *Spinellus*, rather than with *Thamnidium*. Certain marked resemblances to the Oomycetes are also pointed out.

In conclusion I wish to thank Prof. R. R. Gates, at whose suggestion the work was carried out, for his advice and criticism, and also Mr C. S. Semmens for developing and printing the photo-micrographs.

REFERENCES

(1) Schröter, J. (1886). "Über die auf Hutpilzen vorkommenden Mucorineen." *Jber. schles. Ges. für vaterl. Kult.* IV, 183–5.
(2) Vuillemin, P. (1907). "Sur le *Dicranophora fulva* Schröt." *Ann. mycol., Berl.*, V, 33–40.
(3) Ling-Young, M. (1930). "La sexualité chez les Mucorinées." *Rev. gén. Bot.* XLII, 153–4, 210–18, 498, 623–5, 698.
(4) Blakeslee, A. F. (1904–5). "Sexual Reproduction in the Mucorineae." *Proc. Amer. Acad. Arts Sci.* XL, 203–321.
(5) Schröter, J. (1893). "Mucorineae." In Engler-Prantl's *Natürliche Pflanzenfamilien*, 1897, I. teil, Abt. 1, 128–9.
(6) Fitzpatrick, H. M. (1930). *The Lower Fungi. Phycomycetes.* McGraw-Hill Book Co.
(7) Gwynne-Vaughan & Barnes (1930). *The Structure and Development of the Fungi.* Cambridge Univ. Press.
(8) Vernon, T. R. (1931). "An improved type of moist chamber for studying fungal growth." *Ann. Bot., Lond.*, XLV, 733–7.
(9) Dobbs, C. G. (1935). "Two types of modified Petri dish." *Ann. Bot., Lond.*, XLIX, 852–4.
(10) Brodie, H. J. (1931). "The oidia of *Coprinus lagopus* and their relation with insects." *Ann. Bot., Lond.*, XLV, 315–44.
(11) Chesters, C. G. C. (1933). "*Azygozygum chlamydosporum* nov.gen. et sp. A Phycomycete associated with a diseased condition of *Antirrhinum majus*." *Trans. Brit. mycol. Soc.* XVIII, 199–214.
(12) Burgeff, H. (1914). "Untersuchungen über Variabilität, Sexualität und Erblichkeit bei *Phycomyces nitens* Kunze." *Flora*, CVIII, 353–448.
(13) Blakeslee, A. F. (1907). "Heterothallism in the Bread Mold, *Rhizopus nigricans*." *Bot. Gaz.* XLIII, 415–18.
(14) Moreau, F. (1917). "Nouvelles observations sur les Mucorinées." *Bull. Soc. mycol. Fr.* XXXIII, 34.
(15) Green, E. (1927). "The life-history of *Zygorhynchus Moelleri*, Vuill." *Ann. Bot., Lond.*, XLI, 419–35.
(16) Dodge, B. O. (1936). "Reproduction and inheritance in Ascomycetes." *Science*, LXXXIII, 169–75.
(17) Thaxter, R. (1897). "New or peculiar Zygomycetes. II. *Syncephalastrum* and *Syncephalis*." *Bot. Gaz.* XXIV, 1.
(18) Blackman, V. H. (1906). "The 'sexuality' of the Mucorineae." *New Phytol.* V, 215–19.

EXPLANATION OF PLATES X AND XI

Plate X

Dicranophora fulva Schröt. The sporangial stage

Fig. 1. Sporangium showing columella.
Fig. 2. "Sporangial drop" showing shape of columella and spores.
Fig. 3. Part of sporangiole branch system.
Fig. 4. Sporangioles showing early stage in formation of columella.
Fig. 5. Sporangiole branch system.
Fig. 6. Single "giant" spore (30 μ in diameter) in contact with a columella which shows traces of the broken membrane.
Fig. 7. Burst sporangium having a small number of spores.
Fig. 8. Patch of spores formed by the bursting of a sporangium of average size against the cover-slip of a cell.
Fig. 9. Sporangiole mounted in water, showing columella, membrane, and two spores. Taken with 1/12 in. objective.

Fig. 10. Large subsporangial vesicle, separated from the sporangium by a short stalk. Mounted material.
Fig. 11. Sporangiole showing surface encrusted with crystals.
Fig. 12. Sporangial swelling which has produced a branch bearing sporangioles.
Fig. 13. Branch produced by the columella of a burst sporangium, the position of which is indicated by the arrow. The branch has begun to form a young sporangium, but has burst owing to immersion in water. The apparent "collar" round the base of the young sporangium is extruded contents.
Figs. 14–23. A series showing the development of a sporangiole branch system. Times, in hours and minutes from the first photograph: Fig. 14 (0); Fig. 15 (0·30); Fig. 16 (1·0); Fig. 17 (1·30); Fig. 18 (3·20); Fig. 19 (4·50); Fig. 20 (6·50); Fig. 21 (7·50); Fig. 22 (8·30); Fig. 23 (20·0). The last few figures are partly obliterated by a creeping film of water.
Fig. 24. "Oedocephaloid" head bearing five radially arranged "buds" some of which are sprouting *in situ*—produced by a sporangiophore in a moist culture.

Plate XI

The sexual stage

Fig. 25. Group of female "sacs".
Fig. 26. Large female zygophoric branch system, bearing two zygospores, and showing dichotomous branching.
Fig. 27. Single female sex organ, showing granular contents.
Fig. 28. Very early stage in conjugation, probably before contact.
Fig. 29. Early contact. Formation of slight papilla on female branch.
Fig. 30. Later. Considerable outgrowth of female towards male.
Fig. 31. Formation of septum on the male.
Fig. 32. Beginning of female septum. Male gametangium relatively clear of granular contents.
Fig. 33. Young zygospore, showing "antheridial boss" and remains of protoplasm in the large suspensor.
Fig. 34. Earlier stage than Fig. 33, showing thickening of "antheridial" wall.
Fig. 35. Young zygospore with terminal "antheridium" and incompletely septate large suspensor.
Fig. 36. Very early contact of the two sex organs.
Fig. 37. The same, 13½ hours later; the shadows are due to water drops, and encroaching hyphae.
Figs. 38, 39, 40. Stages in the passage of contents of a male into a female gametangium which was losing its contents owing to the effects of illumination.
Fig. 41. Developing zygophoric sac, with a group of unfertilized lobes at its base.
Fig. 42. Zygospore in optical section, showing large oil drop, and the complete obliteration of the lumen of the "antheridium" by the thick double wall.
Fig. 43. Crushed zygospore, focused to show the crevices in the outer coat.
Fig. 44. The same, focused to show the inner hyaline wall, and contents.
Fig. 45. Abnormal zygospore, with imperfect gametangial septum.

1
100μ
2
100μ
3
100μ
4
50μ
5
300μ
6
50μ
7
50μ
8
50μ
9
50μ
10
100μ
11
50μ
12
300μ
13
300μ
14
15
16
17
18
19
20
21
1000μ
22
23
24
100μ

Figs. 14–23

25 300μ
26 500μ
27 100μ
28 100μ
29 100μ
30 100μ
31 100μ
32 200μ
33 100μ
34 100μ
35 200μ
36 100μ
37 100μ
38
39 100μ
40
41 200μ
42 100μ
43 100μ
44 100μ
45 100μ

Figs. 38–40

NOTE ON A RARE BEETLE, *CARTODERE FILUM* AUBÉ, EATING FUNGUS SPORES

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(With Plate XII)

For a number of years it has been noticed that the spores of certain fungi kept in a dry condition in the laboratory of the Royal Botanic Garden, Edinburgh, become compacted, after a time, into little cylindrical masses, which strongly suggest that the spores have been ingested by some small animal, and egested in the faeces. The fungi attacked in this way are those having dry, powdery spores, e.g. species of *Lycoperdon*, *Ustilago* and *Tilletia*.

The faecal pellets (Pl. XII, fig. 1) are roughly cylindrical, straight or slightly curved, generally appearing under the microscope as oblong masses the ends of which may be clean-cut, or more or less irregular. The diameter ranges from 23–37 μ, but much wider variations occur in the length of the masses, measurements from 40 to 200 μ having been obtained; this is readily understandable, as the diameter must be conditioned by the dimensions of the alimentary canal of the animal depositing them, whereas the length of the individual fragments breaking off on deposition is largely fortuitous. These pellets seem to be made up entirely of closely compacted spores, which retain their normal appearance. Presumably they bear a thin coating of mucid substance, to which their cohesion is due, but no interstitial matter is discernible under the microscope. The number of spores which may be counted in the transverse diameter of a pellet, e.g. at one end, depends on the spore size of the species concerned, as illustrated by the following average figures relating to the three species most noticeably affected in the laboratory:

	Average spore size μ	Average number across pellet	Average size × average number μ
Lycoperdon pyriforme	3·9	7	27·3
Ustilago Avenae	5·7	5	28·5
Tilletia Tritici	18·6	2	37·2

The figures for number of spores across the pellet must be taken as approximate only, for the spores are not found arranged in definite rows; being roughly spherical bodies they tend to alternate with each

other. The relatively large spores of *Tilletia Tritici* are never arranged more than two deep (Pl. XII, fig. 2), and actually they are usually a little out of direct alignment except with spores under average size, so that the diameter of the pellets is somewhat less than the product shown in the final column of the table. Making allowance for this, it will be noted that the figures fall within the range already quoted for the diameter of the pellets. It is evident that this somewhat elastic limit is independent of the spore size, and is imposed by the agent responsible for the formation of the pellets, as we should expect if this is the alimentary canal of a small animal.

For some time no animal which might be responsible for this transformation of the spores was noticed, and its presence was merely inferred from the observed effects. Recently the appearance of faecal pellets in the spores of some smutted oats which had been in store only a few months afforded the opportunity for a systematic search, and a small brown beetle was found in considerable numbers. Further examination proved that this was responsible for the damage.

Specimens of the beetle were submitted to Dr A. E. Cameron, of the Edinburgh University Department of Entomology, who identified the beetle as *Cartodere filum* Aubé, of the family Lathridiidae (Clavicornia), and kindly supplied some further information about it. Fowler (1889) comments on this species as follows:

"Very rare; it appears to be chiefly confined to herbaria, although it occasionally occurs in fungi in other countries. Burton-on-Trent (Mr Mason's herbarium, in some small numbers); Scotland, Edinburgh (found by Prof. McNab in the herbarium of the Royal Botanic Gardens)."

The beetle has evidently found, amongst the dried specimens of various fungi, conditions of life and food material which suit it admirably, with the result that it has survived for many years, and now appears to be plentiful and flourishing.

Specimens of *Ustilago Avenae* and *U. Hordei* collected in Wales in August 1935 and stored in the affected cupboards showed no sign of damage in October of the same year, but when these specimens were again being used in February 1936, faecal pellets were abundant in the smutted ears. It was amongst these specimens that search was carried out, and many living mature beetles were found, as well as a fair number of larvae and a few pupae. The beetle was seen to deposit the pellets quite rapidly.

A few beetles were killed, dehydrated in absolute alcohol, cleared in clove oil and mounted in Canada balsam. The contents of the alimentary canal could now be clearly seen, apparently consisting entirely of smut spores which, in the hinder gut, were compacted together into a continuous cylindrical mass (Pl. XII, fig. 3), which broke up on emergence into the characteristic pellets.

The larvae were observed to deposit similar, but generally somewhat more slender pellets, and when a few larvae were cleared and mounted, the spores could be seen in the gut (Pl. XII, fig. 4). They were also present in the gut of the pupae, though these, being quiescent, did not deposit pellets. Fowler (1889) says that "the larvae [of Lathridiidae generally] probably feed on cryptogamic substances, the excrement and skin of various insects, etc." Here larvae and adults alike were apparently subsisting on the same pure diet of one cryptogamic substance, namely smut spores.

The unaffected spores of *Ustilago Avenae* and *U. Hordei* (collected August 1935) were still viable in February 1936, germination beginning after a few hours in water. As the spores constituting the faecal pellets were not visibly altered except as to their arrangement, these were tested for viability. To ensure that the spores used had actually passed through the alimentary canal, a living beetle was kept under observation in a clean hollow-ground slide, where it was seen to deposit pellets of spores. These were transferred to a hanging drop of water.

Most of the spores failed to germinate, but a few produced their promycelia and sporidia within eighteen hours, when the photograph (Pl. XII, fig. 5) was taken; by this time the bacteria present in the faeces had multiplied very considerably. The relatively long period of eighteen hours should not be stressed too heavily; the spores had germinated overnight within this time, and even in experiments with unaffected spores some always took a good deal longer than others to germinate. But one evident difference was the very small number of spores which had germinated even after eighteen hours. In drops where both unaffected spores and pellets were present the promycelia of the former were generally so abundant as to hamper observation of the latter, and frequently when a promycelium appeared to proceed from one of the pellets the possibility remained that it might belong to an unaffected spore adhering to the mass. But where fresh pellets only were introduced into the drop, it was very noticeable that most of the spores showed no signs of germination.

From this it appears that, while spores may survive and germinate after passage through the alimentary canal of the beetle, they are nevertheless subject to some adverse influence to which most of them succumb. This lethal effect was probably caused by the digestive juices of the beetle.

The exact composition of the spore wall of *Ustilago* appears to be unknown, but it may be taken that it consists mainly or entirely of some form of cellulose. Microchemical tests show that it is not the same form of cellulose as is found in the cell walls of the higher plants and of a few fungi, such as *Peronospora*. For example, spores of *Ustilago* and *Peronospora* were mounted together and tested with

sulphuric acid and iodine, when the spore wall of *Peronospora* gave the blue colour reaction characteristic of cellulose, while that of *Ustilago* simply assumed a yellowish brown tint. It has been customary to refer to the substance of such walls as "fungus cellulose", as it is believed to consist essentially of cellulose, though in a slightly different form from that occurring in the majority of plants.

If this be so, it would appear from the reduced germination capacity of the egested spores that these must have been acted upon by an enzyme capable of dissolving, at least in part, their protective covering, that is to say, by a cellulase.

According to Mansour & Mansour-Bek (1934) no evidence of the presence of cellulase in insects had been obtained prior to 1919, and any digestion of cellulose which might take place was believed to be due to the presence of micro-organisms in the intestinal tract. Subsequent to 1919, however, cellulase has been recorded in a number of insects, including wood-eating beetles. It is therefore quite possible that *Cartodere filum* may secrete cellulase, especially as the herbarium material on which it generally lives must contain a high percentage of cellulose, but I know of no experimental information on this point.

Reference may be made here to the digestion of spores of *Tilletia Tritici* by animals. These spores have been found in the faeces of several vertebrates (man, dog, rabbit, guinea-pig, etc.) and appear to be affected but little if at all by their passage through the digestive tract (Dobson, 1926). Conflicting results have been reported as to their capacity for germination when obtained from the faeces. In vertebrates the breakdown of cellulose is generally admitted not to be the work of a cytase, but due mainly to the action of intestinal bacteria. It is possible that the conflicting results may be related to variations in the composition of the bacterial flora.

It was not possible to test the viability of egested *Tilletia* spores, as the material available was old, and even the unaffected spores were not capable of germination. The spores of *Ustilago* on which the observations of germination were made were six months old; fresher spores might have germinated more freely.

No attempt has been made here to deal in detail with the entomological aspect of the problem. The purpose of this note is rather to record the agent responsible for the appearance of these characteristic pellets amongst dry fungus spores, the persistence in the laboratory of this rare beetle, and the fact that spores are capable of germinating after passing through the alimentary canal of the beetle, but do suffer a reduction in their capacity for germination.

I am indebted to Dr Malcolm Wilson for the suggestion that this problem might be worthy of investigation, and its explanation of interest to other workers.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

REFERENCES

Dobson, N. (1926). "The toxicity of the spores of *Tilletia Tritici* to animals." *Trans. Brit. mycol. Soc.* xi, 82–91.
Fowler (1889). *British Coleoptera*, vol. iii. London.
Mansour, K. & Mansour-Bek, J. J. (1934). "The digestion of wood by insects and the supposed role of micro-organisms." *Biol. Rev.* ix, 363–82.

EXPLANATION OF PLATE XII

Fig. 1. Basidiospores of *Lycoperdon pyriforme*, egested by *Cartodere filum*, as seen under a low power.
Fig. 2. Chlamydospores of *Tilletia Tritici*, egested by *Cartodere filum*.
Fig. 3. *Cartodere filum* Aubé; the mature beetle cleared to show the dark mass of spores of *Ustilago Avenae* in the gut.
Fig. 4. *Cartodere filum*; larva with spores of *Ustilago Avenae* in the gut.
Fig. 5. Chlamydospores of *Ustilago Avenae*, egested by *Cartodere filum*; photographed after eighteen hours in water; a few spores in the smaller mass have germinated.

CONTRIBUTIONS TO THE STUDY OF *PENICILLIUM EGYPTIACUM* VAN BEYMA

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(With Plate XIII and 10 Text-figures)

Introduction

The genus *Penicillium* includes several hundred species, and is cosmopolitan in distribution. Most species, so far as is known, multiply exclusively by means of conidia, but in a few species perithecia may develop. This development may depend upon some special cultural or other environmental condition, such as diminution of the supply of free oxygen (3, 21) or an abundant supply of sucrose (1). Heterothallic (6) and homothallic (18) species have been described. Several authors (7, 12, 13, 15, 20) have found perithecia in species of *Penicillium* without ascribing their formation to any special circumstances.

P. egyptiacum, a form isolated from soil in Egypt (16), develops perithecia in great numbers on ordinary media (17). It is proposed to give some account of the morphology of this species, and of its behaviour in culture.

Experimental work

Cultural characters

P. egyptiacum has been grown on more than thirty media of very different nutritive values. These media included synthetic agars, plant decoction agars, and nutrient solutions, as well as plugs of vegetable material of divers kinds. The more striking results of these experiments are summarized below.

On Conn's medium and Barnes's medium, the mycelium formed thin, smooth, shining and somewhat transparent mats. Aerial mycelium developed as rope-like strands of inter-twisted hyphae bearing conidiophores. The perithecia were scattered over the surface of the medium in fair numbers (Pl. XIII, fig. 1), but they were not crowded together.

On malt agar, date extract agar (16), Brown's agar, and Richard's solution agar, the comparatively short and crowded hyphae produced a dense growth. Aerial mycelium was luxuriant. Young colonies were white, not only because of the closely packed hyphae, but because of the enormous numbers of perithecial primordia. As the

latter matured, they imparted a brown, granular aspect to the colony. On Richard's solution agar, the mycelium and the substratum became wrinkled, and later, cracked (Pl. XIII, fig. 2).

Some preliminary tests were made on the effect of the source of nitrogen. For this purpose, a medium of the following general composition was prepared:

	%
Glucose	2
Tripotassium phosphate	0·5
Magnesium sulphate	0·17
Agar	2
A nitrogenous compound	1

When ammonium chloride was used, conidiophores developed in large numbers, and the chains of conidia were exceptionally long. The colonies were velvety in texture and uniformly green, owing to the abundant conidia, but perithecia were rare. When asparagin supplied the nitrogen, growth was soon arrested by staling, and only very few perithecia appeared.

Text-fig. 1. Oidia-like bodies developed on lime fruit. ×550.

Growth was weak, and perithecia scanty, on a medium containing filter paper as the only source of carbon.

Strong vegetative development, with heavy crops of perithecia, was obtained on plugs of potato and of carrot. *P. egyptiacum* grew and fruited well on the fruits of orange, mandarine and lime; on the latter, the mycelium showed a special tendency to produce thick-walled structures resembling oidia (Text-fig. 1). The addition of compounds of arsenic to media led to the formation of short, richly branched hyphae; these cultures did not emit a garlic-like odour.

Saltation

Sectoring was frequently observed; in general, the sectors consisted either of a dense, brown, granular growth rich in perithecia, or of a green velvety area, covered with conidiophores, but containing very few perithecia. A transfer to malt agar from a green sector gave a homogeneous green colony which retained these characteristics

through the four subsequent transfers that were made (Pl. XIII, figs. 3, 4).

Zonation

Zonation was observed occasionally on Brown's agar and malt extract agar, and also when cultures were grown under reduced atmospheric pressure. The saltant which produced heavy crops of conidia showed zonation on malt agar and on Barnes's medium.

Influence of temperature

Three cultures were grown on malt agar at each of the following temperatures: at about 4° C. in an ice-box, at 13–14·5, 18, 22, 26, 30 and 34° C. The results appear in Table I.

Table I. *Influence of temperature on* Penicillium egyptiacum

	Diameters (in mm.) of colonies at						
Days	4° C.	13–14·5° C.	18° C.	22° C.	26° C.	30° C.	34° C.
2	3	6	6·7	7·3	7·3	7·5	3
4	No more growth	10·2	13·3	13·3	13	12	5
6	,,	15	17·7	18·2	18	15·4	No more growth
8	,,	19·5	22·7	23	23·5	20·4	,,
10	,,	24	26·7	28	28	23·5	,,
12	,,	26	29	32	32	28	,,
14	,,	30	33	36	36·5	31	,,
30	,,	—	60	69	72	52	,,

The diameters are the averages of two measurements taken from each culture of the triplicate sets.

These data indicate that the optimum temperature for growth lies between 22° and 26° C. There is, however, little difference in the strength of growth at any temperature between 14° and 30° C. In all cultures where growth continued, perithecia developed in the normal manner.

Some cultures were left for six weeks at 4° and at 34° C., transfers being then made to malt agar slants, which were incubated at 22° C. Since normal colonies resulted, it is evident that the fungus had suffered no injury during the time it had been exposed to temperatures unfavourable to growth.

*Influence of the p*H *of the medium*

Penicillium egyptiacum was grown on Richard's solution agar, adjusted by additions of phosphoric acid or of sodium bicarbonate to various hydrogen-ion concentrations. After autoclaving, the *p*H of the agars was determined by the colorimetric method (4). From the many media prepared, samples were selected with the following range of *p*H: 3·8, 4·8, 5·8, 6·8, 7·8 and 8·8. Three Petri dishes were poured

from each lot of these media, inoculated, and incubated at 22° C. The results are summarized in Table II.

Table II. *Influence of pH of the medium on* Penicillium egyptiacum

	Diameters (in mm.) of colonies at *p*H					
Days	3·8	4·8	5·8	6·8	7·8	8·8
2	6	6	4·25	4·5	4	4·5
4	18	16	15·75	14·75	14	13·75
6	28·75	24	27	25·5	22·5	26
8	36	31·25	36	35	30·5	33
10	45·75	38·75	43	43	38·5	39
20	78	73	76	77	75	75

The diameters are the averages of two measurements taken from each culture of the triplicate sets.

The figures in Table II indicate, that within the range tested, the *p*H of the medium has no significant effect upon the growth of *P. egyptiacum*. It was noted, however, that perithecia developed later on the media with a *p*H 8·8 than on the other media.

Influence of atmospheric humidity

Six large crystallizing dishes were sterilized and provided with a range of aqueous solutions of calcium chloride (14) giving the following atmospheric humidities at 20° C.: 100, 96, 90, 80, 70 and 60 %.

Twelve small Petri dishes containing malt agar were inoculated with *P. egyptiacum* and attached in pairs, upside down, to the inside of the lids of the crystallizing dishes. The lids of the Petri dishes were removed so that the media were freely exposed to the atmosphere in the larger dishes. Access of air was checked as far as possible by packing cotton-wool into the spaces between the lids and bottoms of the crystallizing dishes.

The preparations were incubated at 20° C. for ten days, when the diameters of the colonies were measured. The results appear in Table III.

Table III. *Influence of atmospheric humidity on* Penicillium egyptiacum

Moisture %	Diameter of colony mm.	Characters of colony
100	26	Powdery brown, perithecia crowded
96	25	,, ,,
90	14	Velvety, greenish, perithecia scanty
80	9	Velvety, greenish, perithecia absent
70	6	,, ,,
60	5	,, ,,

The diameters are the averages of two measurements taken from each culture of the duplicate sets.

It seems that the formation of perithecia occurs freely only in very moist atmospheres. At about 90 % humidity, conidial formation assumes the upper hand, and perithecia become rare, while at 80 % humidity and below, perithecia cease to form. These results are in agreement with those obtained by Blochwitz (2) and by Schwartz (19) with species of *Aspergillus*.

Influence of light

Six dishes of malt agar were inoculated with *Penicillium egyptiacum*. Three were covered with black enamel and placed in a large dish, similarly darkened. The remaining three dishes were placed in a large, undarkened dish. Both preparations were left for thirty days on a bench opposite to a window. It was then found that the colonies grown in the light averaged 70 mm. in diameter, while those grown in the dark averaged 45 mm. in diameter. All the cultures had produced perithecia. Those developed in the light were scattered, and less numerous per unit area than the perithecia in the darkened dishes. It appears therefore that light favours the mycelial growth of *P. egyptiacum* and depresses the formation of perithecia, darkness having the opposite effect.

Influence of atmospheric pressure

Two batches of malt agar slants were inoculated with *P. egyptiacum* and incubated at 25° C. for twenty-four hours. When it was clear that growth had begun, one batch was placed in a desiccator attached to an air pump. This was run for three hours, when the tap of the desiccator was closed. The other batch was placed in a desiccator with the tap open. Both were left for a month at 18–22° C. The tap of the exhausted desiccator was then opened, and since air was heard to rush in, it was evident that the fungus had been under reduced pressure during the whole time of the experiment. The cultures grown under reduced pressure were zoned with alternate bands of greenish conidial areas and closely compact, brown ridges of perithecia; the cultures kept at atmospheric pressure were even and unzoned.

The morphology and cytology of Penicillium egyptiacum *methods*

Slides were thoroughly cleaned from grease and other dirt, placed in Petri dishes, sterilized, and covered with a thin layer of Barnes's medium. This medium was used, since it is clear, and being of low nutritive value, the mycelium grows loosely on it, and the scattered perithecial rudiments are easy to examine. The cultures were inoculated and incubated at 25° C., for four or five days. The fungus was then fixed by adding to the dishes a quantity of strong Flemming's

solution diluted with an equal volume of water. After washing, and taking up through the usual series of alcohols, the material was stained by the glycerine-erythrosin method (11). Up to this point, all operations were done on the fungus in the dish, care being taken to disturb it as little as possible. The slides, covered by a thin film of agar, were then removed, and the stained material mounted in warm glycerine jelly. The preparations were sufficiently thin to be examined with an oil immersion objective.

Other material, grown and fixed in similar manner, was stained in Heidenhain's iron haematoxylin, and used for a study of the nuclei in the conidiophores and conidia.

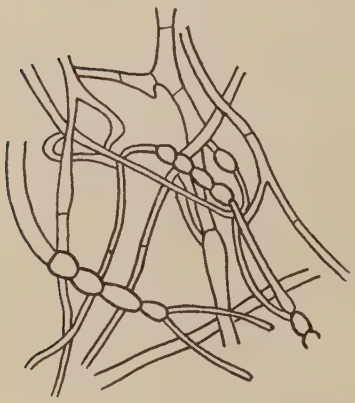
In order to investigate the perithecia, the fungus was grown on malt agar, fixed in the fluid 2BD of La Cour (5), embedded in paraffin, cut at 5 μ, and stained with iron haematoxylin, with erythrosin in clove oil as a counter-stain.

Development of the reproductive organs.

Perithecia. Some hyphae rise slightly above the substratum and form extensive branch systems with frequent anastomoses. They give rise to aerial knots, which are the primordia of the perithecia. Certain stout hyphae, distinguished by their close septation and rich contents, become centres of activity and are soon surrounded by wefts of anastomosing hyphae. These hyphal masses are soon surrounded by a pseudo-parenchymatous envelope, and within this the asci subsequently develop. Sometimes complicated hyphal masses are found in which the stout, septate hypha cannot be clearly distinguished. Spirally wound primordia have never been seen, nor has anything suggesting an antheridium been found.

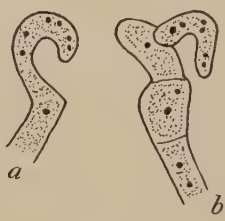
Serial sections of young perithecia reveal a mass of solid ground tissue with the remains of darkly stained septate hyphae embedded in its centre (Pl. XIII, fig. 5). These hyphae are still distinguished by their rich contents and thin walls, and although they may be somewhat curved, they are not spirally wound. It seems the archicarp of *P. egyptiacum* is merely a stout, closely septate hypha (Text-fig. 2), rich in contents, and but slightly curved. It puts out branches, closely septate and rich in contents, and these give rise to much narrower ascogenous hyphae, which are short and curved in a characteristic fashion (Text-fig. 3). Each becomes septate, and each segment then becomes an ascus (Text-fig. 5 *c*, *d*). The first branches to emerge from the archicarp are multinucleate, as are the young ascogenous hyphae which contain pairs of nuclei in close association. The septa form between the pairs of nuclei, cutting off the rudiments of the asci. The first ascus matures at the tip of the ascogenous hypha, and a second, third, and sometimes a fourth (Text-fig. 4) ripen in succession below it; the asci are thus formed in chains.

Young asci containing four nuclei were recognized, but as nuclear fusions have not been detected, it is not clear if all the binucleate cells that were observed were of the same kind. Some were doubtless the binucleate segments of the ascogenous hyphae, others were probably young asci in which the first nuclear division had occurred. It seems very probable that the two nuclei fuse in the young ascus, and that



Text-fig. 2. Perithecial initial. ×666.

Text-fig. 3. Ascogenous hyphae drawn from young fresh perithecia. ×1500.



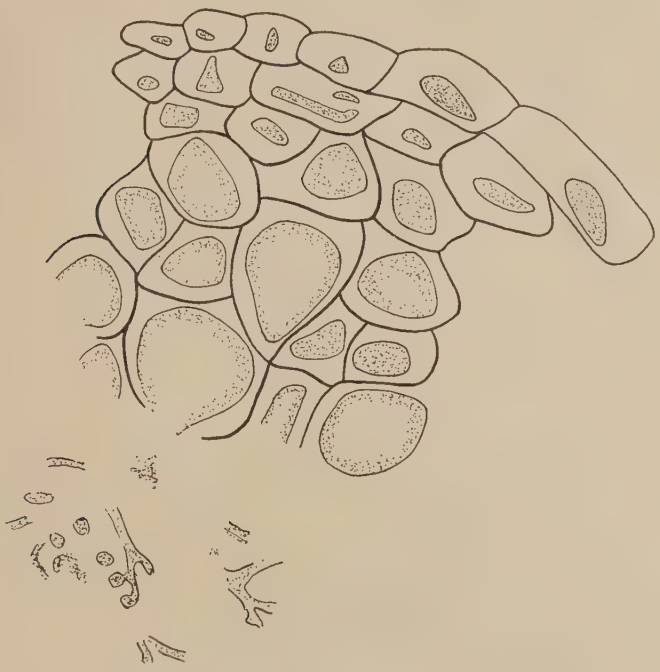
Text-fig. 4. Asci drawn from fresh perithecia. ×2500.

Text-fig. 5. Ascogenous hyphae in different stages of development. ×2500.

three rapidly succeeding divisions give the eight nuclei for the eight ascospores. These may be seen clearly in the ascus (Text-fig. 4), as Emmons has already shown (8).

The outer layers of the fruit body are compact and composed of thick-walled hyphae, but the inner layers are less dense, and have thin walls (Text-fig. 6). As the fertile hyphae grow and branch, the sterile ground tissue of the perithecium disintegrates from the centre

towards the periphery, until a few layers only of the wall remain. The cavity is occupied by the asci and by the remains of the ascogenous hyphae (Pl. XIII, fig. 6), the walls of the asci also disappearing as the fruit body reaches maturity. The ascospores lie free in the lumen of the ripe fruit, surrounded by a wall three to four layers thick. They are dispersed by the decay of the wall, or by its rupture.



Text-fig. 6. Sclerotic perithecial wall and remains of ascogenous hyphae. × 1500.

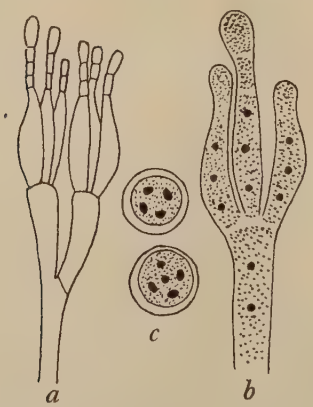
The ascospores are barrel-shaped, surrounded by a wall consisting of a thin inner layer and a thick outer layer. There is a longitudinal furrow in the outer wall, bordered by two more or less prominent ridges. At germination, the ascospore swells and puts out a germ tube opposite the furrow (Text-fig. 7).

Perithecia may be obtained from cultures started from a single conidium or a single ascospore; *Penicillium egyptiacum* is homothallic.

Mycelium and conidiophores. The hyphae consist of multinucleate segments with strongly vacuolated contents, septa being usually

widely spaced. The segments of the conidiophores, as well as the metulae, are multi-nucleate (Text-fig. 8), and the conidia contain four or five nuclei (Text-fig. 8*c*). At germination, the conidium

Text-fig. 7. Germinating ascospores. *a*, × 1500; *b*, × 500.

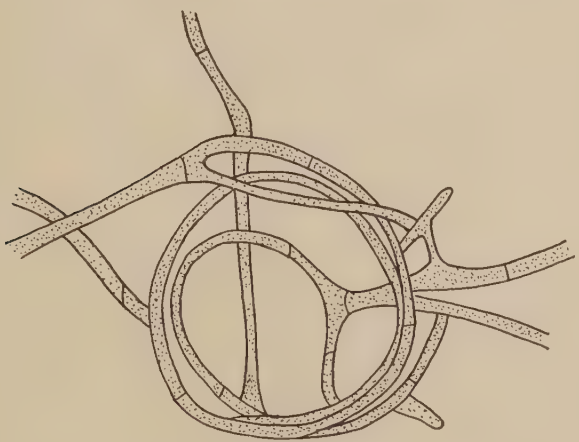


Text-fig. 8. Conidiophores and conidia. *a*, × 1500; *b*, × 2500; *c*, × 3000.

swells to about three times its original size, and puts out one or more germ tubes (Text-fig. 9).

Occasionally flat coils of hyphae occur in the cultures (Text-fig. 10). They bear conidiophores, and they do not give origin to perithecia.

Text-fig. 9. *a*, conidia before germination; *b*, during germination. All × 1000.



Text-fig. 10. Flat mycelial coils. × 2500.

Conclusion

It is not necessary to utilize special conditions of culture to obtain the perithecia of *P. egyptiacum*. This species grows on a wide range of substrata. When these are of low nutritive value, the colonies are thin, and the conidiophores have a special tendency to form on rope-like strands of the aerial mycelium; perithecia develop in very small numbers on poor media. When there is a good supply of carbohydrates, vegetative growth is strong and perithecia abound. It seems likely that the conditions which favour the growth of the perfect stage depress conidial development, but the reverse is not true, for

perithecia were seen on every medium on which the fungus would grow. They began to appear, usually, during the second or third day after the culture was started, at 25° C. By the end of the week cultures were distinctly brown with perithecia.

P. egyptiacum differs considerably from the species described by Brefeld (3), Dangeard (7) and Fraser & Chambers (9), since it neither possesses an antheridium nor is the archicarp coiled. It closely resembles *P. Ehrlichii*, described by Klebahn (12), which has a perithecial rudiment consisting of a thick, nearly straight septate hypha, and has no antheridium.

The rapid formation of ascogenous hyphae by *P. egyptiacum* distinguishes the species clearly from the members of the *P. "crustaceum"* group, in which, according to Brefeld (3), asci develop in a sclerotium-like body only after a long period of rest. Klebahn (12) mentions that Morini (15) found that the sclerotia of *P. candidum* begin to contain asci about a fortnight after the development of the sclerotium, and that the ripe perithecia have a thin few-layered wall, covered externally by the granular remains of the disorganized outer envelope, and enclosing a cavity wholly filled by intact asci with ascospores. Klebahn noted that the perithecia of *P. Ehrlichii* mature rapidly and have a two-layered wall.

In *P. egyptiacum* the fruit body begins as a compact mass in which ascogenous hyphae may be found. They branch and develop without any period of rest, and soon give asci. The mature perithecial wall is three or four layers thick, and its cavity contains free ascospores. There is no envelope. In general, this species, apart from the absence of an inactive period, agrees with the "truffle" type of Sopp (20).

Gäumann (10) distinguishes two types of ascogenous hyphae in the genus. The first occurs in *P. vermiculatum*, where the ascogenous hyphae are converted into a chain of binucleate cells without any arrest in development, these yielding asci after a nuclear fusion. The second occurs in *P. crustaceum*. In that species inconspicuous aseptate ascogenous hyphae lie inside the hard sclerotium, but, some two months after the sclerotia are sown, the ascogenous hyphae become segmented into stout, cylindrical, and apparently binucleate segments. There is further complicated branching before the asci finally appear.

In *P. egyptiacum* the ascogenous hyphae are cut into a chain of binucleate segments by septa appearing at a late stage of development, but the nuclear behaviour has not yet been worked out.

Penicillium egyptiacum presents many points of interest, and further work is needed to complete many of the experiments briefly described in this preliminary account.

SUMMARY

1. *Penicillium egyptiacum* isolated from soil in Egypt, differs from most species of the genus in producing perithecia with readiness on most common media.

2. Tests of its behaviour at various temperatures, on media of different *p*H, in conditions of different humidity and at reduced atmospheric pressure, show that special conditions of the environment have no particular effect on the formation of the perithecia. Of the conditions tested, humidity seems to exert most effect.

3. The archicarp is not coiled, but has the form of a short, stout septate hypha.

4. Asci develop rapidly, and not after a period of inactivity.

5. The species is homothallic.

REFERENCES

(1) BEZSSONOV, N. (1919). "Über die Züchtung von Pilzen auf hochkonzentrierten rohrzuckerhaltigen Nährböden und über die Chondriomfrage." *Ber. dtsch. Bot. Ges.* XXXVII, 136–48.

(2) BLOCHWITZ, A. (1932). "Perithezien, Sklerotien und Eidamsche Blasen der Aspergillaceen." *Beihefte Bot. Zbl.* XLIX, Abt. 1, 262–92.

(3) BREFELD, O. (1874). *Botanische Untersuchungen über Schimmelpilze.* II. *Penicillium.*

(4) CLARK, W. M. (1928). *Determination of Hydrogen Ions.* London.

(5) LA COUR, L. (1931). "Improvement in everyday technique in plant cytology." *J. R. Micr. Soc.* LI, 119–26.

(6) DERX, H. G. (1926). "Heterothallism in the genus *Penicillium*." *Trans. Brit. mycol. Soc.* XI, 108–12.

(7) DANGEARD, P. A. (1907). "Recherches sur le développement du perithèce chez les Ascomycètes." *Botaniste*, X, 1–385.

(8) EMMONS, C. W. (1935). "The ascocarps in species of *Penicillium*." *Mycologia*, XXVII, 128–50.

(9) FRASER, H. C. I. & CHAMBERS, H. S. (1907). "The morphology of *Aspergillus herbariorum*." *Ann. Mycol., Berl.*, V, 419.

(10) GAUMANN, E. A. (DODGE, C. W.) (1928). *Comparative Morphology of Fungi.* New York.

(11) GWYNNE VAUGHAN, H. C. I. & BARNES, B. (1927). *The Structure and Development of Fungi.* London.

(12) KLEBAHN, H. (1930). "*Penicillium Ehrlichii*, ein bemerkenwerter neuer Schimmelpilz." *Ber. dtsch. bot. Ges.* XLVIII, 374–89.

(13) KLÖCKER, A. (1903). "Om Slogtem *Penicilliums* Plads i Systemet og. Beskrivelse af en ny ascusdannende Art." *C.R. Trav. Carlsberg*, VI, 84.

(14) LANDOLT, H. H. & BOERNSTEIN, R. (1883). *Physikalische chemische Tabellen.* Berlin.

(15) MORINI, F. (1888–9). "Sulla forma ascofora de *Penicillium candidum* Link." *Malpighia*, II, 224.

(16) SABET, Y. S. (1935). "A preliminary study of the Egyptian soil fungi." *Bull. Fac. Sci.* No. 5, Egyptian Univ.

(17) —— (1936). "Preliminary study of *Penicillium egyptiacum*." *Zbl. Bakt.* XCIV, ii, 97–102.

(18) SCHWARTZ, W. (1926). "Über ein *Penicillium* mit fertilen Sklerotien." *Ber. dtsch. Ges.* XLIV, 648–52.

(19) —— (1928). "Entwicklungsphysiologische Untersuchungen über die Gattungen *Aspergillus* und *Penicillium*. I. Teil *Aspergillus* Arten." *Flora*, N.F. XXIII, 386–440.

(20) Sopp, O. J. O. (1912). "Monographie der Pilzgruppe *Penicillium* mit besonderer Berücksichtigung der in Norwegen gefundenen Arten." *Vidensk. Skr. Mat. Nat.* xi, 1, Kristiania.
(21) Zukal, H. (1887). "Über Kultur der Askenfrüchte des *Penicillium crustaceum*." *Abh. zool.-bot. Ges. Wien*, xxxvii, 66.

EXPLANATION OF PLATE XIII

Fig. 1. *Penicillium egyptiacum* grown on Barnes's medium.
Fig. 2. *P. egyptiacum* grown on Richard's sol. agar.
Fig. 3. Sectors on malt agar.
Fig. 4. Saltant with very few perithecia and tremendous crop of conidia.
Fig. 5. Young perithecium filled with sterile tissue: the remains of ascogenous hyphae are darkly stained near the centre. × 150.
Fig. 6. Perithecia in course of development. × 136.

Fig. 1

Fig. 2

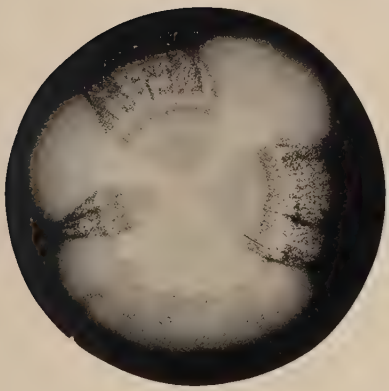


Fig. 3

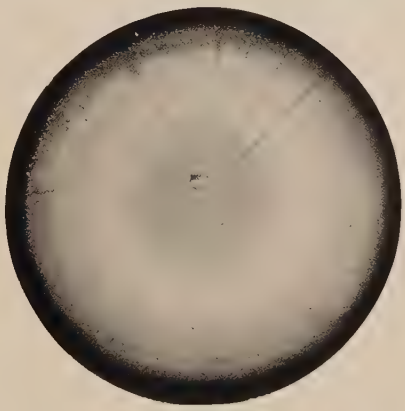


Fig. 4

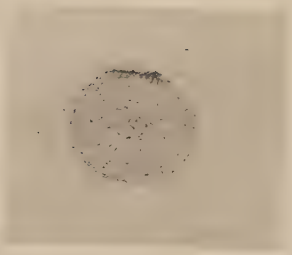


Fig. 5

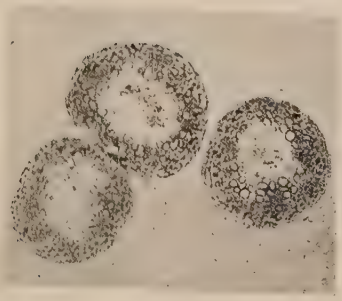


Fig. 6

THE ORIGINAL AND MODERN CONCEPTIONS OF *STEMPHYLIUM*

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(With Plates XIV and XV and 17 Text-figures)

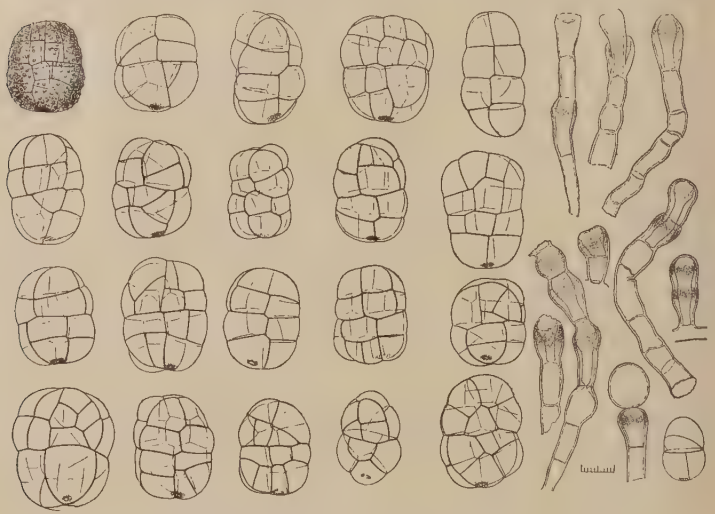
The original conception of *Stemphylium*

The genus *Stemphylium* was founded by Wallroth in 1833 on the single species *S. botryosum*. The description of the genus reads: "Hyphae [i.e. conidiophores] simplicissimae breves articulatae nodulosae, vertice incrassato sporidium ovatum subangulatum longitudinaliter transversimque septatum, veluti multiloculare sustinentes." This implies fungi with the conidiophore swollen at the apex and with "short nodular segments" bearing an ovate, subangular, muriform spore. The diagnosis of the species reads: "Hyphis articulato-nodulosis abbreviatis erectis in fasciculos distinctos gregatimque excurrentes junctis fragilibus, sporidio ovato subangulato longitudinaliter transversimque septato, veluti concamerato laxe appenso opaco nigro majusculo terminatis." The nodular segments of the conidiophore and the ovate, subangular shape of the muriform spore are again mentioned, and though the swollen apex of the conidiophore is not referred to, the description of the nodular segments clearly shows that such a swelling must have occurred, as the nodular segments are nothing more than the succession of swollen apices.

The specimen from which Wallroth very probably described the species is preserved in Herb. Wallroth at Strasbourg University, and through the kindness of Prof. Chermezon I was permitted to borrow it for examination. It consists of four pieces of stem gummed on a small card bearing the label "Stemphylium botryosum *W.* ad Asparagum" presumably in Wallroth's handwriting (Pl. XIV, fig. 1). The information given by the label is meagre, but Prof. Chermezon remarks that this is usual in Wallroth's herbarium. The host, asparagus, is the "type host" for the species, the original collection having been recorded on dried stems of asparagus.

The fungus agrees entirely with that indicated by the diagnosis (Text-fig. 1). The conidiophores are fasciculate, in groups ranging from three or four to upwards of fifty, apparently arising from an immersed stromatic cushion, or sometimes sparsely on a superficial mycelium. They are dark in colour, occasionally branched, septate

at intervals of about 9 or 10 μ, mostly from 30–70 or 80 μ long and 5–7 μ wide but swollen at the apex to a diameter of 7–10 μ. The apical swelling is darker below than in the upper half and is thickened by an inner wall. The growth of the conidiophore through the apex, giving rise to a succession of "nodular segments", is clearly recognizable; up to four swellings were observed, the distance from the top of one to that of the next varying from 10 to 50 μ. The organization of the conidiophore corresponds with that described below for *Macrosporium sarcinaeforme* and already recorded by Miyake for *M. parasiticum*. The conidia are dark, verrucose, roughly oval or subangular,



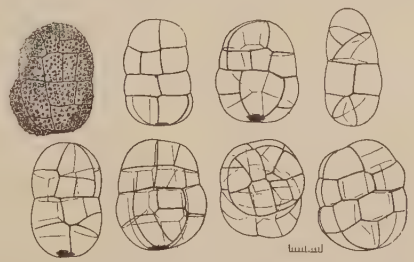
Text-fig. 1. *Stemphylium botryosum* Wallroth. Conidiophores and conidia drawn from Wallroth's specimen. × 500.

slightly constricted at the median transverse septum and to a lesser degree at the other cross-walls, muriform with transverse, vertical and oblique septa dividing the conidium into many cells, with a prominent basal scar, and measure 24–39 × 19–31 μ.

The identity of *Stemphylium botryosum* with the conidial stage of *Pleospora herbarum*

There can be little doubt that *Stemphylium botryosum* Wallroth is the fungus which has been known in the literature as *Macrosporium sarcinula* Berk. (or *M. parasiticum* Thüm.) the conidial stage of *Pleospora herbarum* Rabenh.

Berkeley described *Macrosporium sarcinula* in 1838 on decaying orange gourds, collected at King's Cliffe. The type material of *M. sarcinula* in Herb. Kew. consists of a small, rather curled up piece of orange rind, with one large blackish spot towards the edge, 9 mm. across in its maximum diameter; pinpricks indicate that another portion was formerly attached to the paper on which the specimen is mounted. It is labelled "*Macrosporium sarcinula*, Berk. Ann. of N.H. King's Cliffe, ex herb. Berk." in Berkeley's handwriting. There are five other specimens of Berkeley's in the folder, but those from King's Cliffe, the type locality, are of a later date than 1838. The two fungi confused by Berkeley in his original description of the fungus (Pl. XIV, fig. 2) are present on the specimen, viz. one "with short clavate filaments" (a species of *Alternaria*), and the other with spores which have "a rectangular outline and resemble very much little corded bales, from which circumstance the name is taken". Berkeley considered the former to be the immature stage of the latter, but this has not proved to be so. Only a very few sarcinaeform conidia were found in preparations made from the type, whereas large numbers of the *Alternaria* occurred. The sarcinaeform conidia obtained from the specimen (Text-fig. 2) were ovoid-oblong with a constriction at the median transverse wall, light brown, covered with small discrete warts and marked with a conspicuous basal scar; the measurements of the few spores seen ranged from 31–35 × 20–26 μ. They agree very well with those of the type specimen of *Stemphylium botryosum*.



Text-fig. 2. *Macrosporium sarcinula* Berk. Conidia drawn from the type specimen. ×500.

The conidia observed did not represent the full range of variation which they attain, for Berkeley figured them much longer, more angular, and much more resembling "bales of cotton" in shape (Pl. XIV, fig. 2). No conidiophores were observed in the type material, but Berkeley remarked that "a few of the peduncles [conidiophores] are seen amongst the sporidia, their articulations being swollen above", and his figure agrees with those of *S. botryosum*.

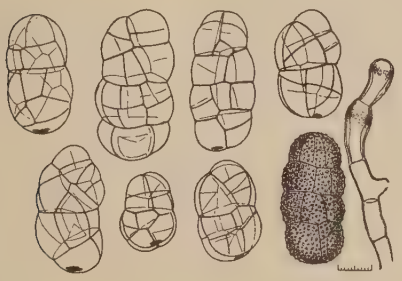
The association of *Macrosporium sarcinula* with *Pleospora herbarum* as its ascigerous stage really dates from the Tulasnes who, in 1863, cited the former (among various other species) as the conidial stage of the latter and also figured germinating ascospores bearing the

characteristic conidiophores with conidia attached. Gibelli & Griffini in 1872 named the ascigerous stage *P. sarcinulae* (=*P. herbarum*), and they also illustrated an ascospore bearing two conidiophores and conidia attached. Miyabe in 1889, studying the fungus on onion, proved the genetic connexion between the conidial stage, named *Macrosporium parasiticum* by von Thümen in 1877 (Myc. Univ. 667), with *Pleospora herbarum* by pure cultures and expressed the opinion that *Macrosporium sarcinula* Berk. was the same fungus, though he did not examine type material of this species. Prillieux & Delacroix (1893) doubted whether *M. parasiticum* could be maintained as a species distinct from *M. sarcinula*, and suggested it may form the conidial stage of *Pleospora herbarum*; they were evidently not aware of Miyabe's paper. Hanzawa (1915) suggested that the seven species of *Macrosporium* recorded by Saccardo on *Allium* (including *Macrosporium sarcinula*) are all perhaps identical with, or nearly related to *M. parasiticum*. Teodoro (1923) considered that Miyabe had established the identity of *M. parasiticum* with *M. sarcinula*, but throughout his paper he refers to the onion parasite as *M. parasiticum*, which he confirmed as the conidial stage of *Pleospora herbarum*. Kidd & Beaumont (1924) obtained the conidial stage (which they call *Macrosporium commune* Rabenh.) with its ascigerous stage, *Pleospora herbarum*, in culture. Bolle (1924) maintained that *Macrosporium parasiticum* and *M. sarcinaeforme* (which she regarded as identical with it) are merely strains of *Pleospora herbarum*, for the conidial stage of which the name *Macrosporium sarcinula* should be retained. Machacek (1929) & Ellis (1931) confirmed the relation between *M. parasiticum* and *Pleospora herbarum*. Verwoerd & Du Plessis (1931) stated that *Macrosporium sarcinula* is the conidial stage of *Pleospora herbarum* on the onion.

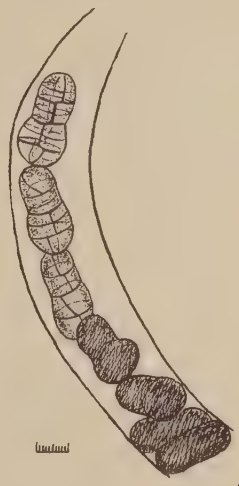
Von Thümen's exsiccatum of *Macrosporium parasiticum* comprises excellent material from which Text-fig. 3 has been drawn. The conidia are longer than observed in the type of *M. sarcinula*, but, taking into account Berkeley's figure, there is very strong evidence that the two species are identical. The spores of *M. parasiticum* are also longer than those of *Stemphylium botryosum*, but nevertheless I would regard both as belonging to the same species and, consequently, *Macrosporium sarcinula* and *M. parasiticum* as synonyms of *Stemphylium botryosum*. The fungus is common, occurring on a wide range of hosts and very probably has been known under a number of names. In culture the conidia are definitely smaller than on the host as recorded by Bolle (cf. Bolle, 1924, p. 63 and Pl. III, figs. F, G, H, I). The extreme measurements of conidia collected on dying onion leaves at Oakley, Hants, in 1932 were 21–49 × 10–22 μ, whereas in culture they were 20–26 × 12–18 μ, the measurements indicating a change of shape as well as of size. Seeing such variation occurs in culture it may also be expected to occur on different hosts in nature, and minor differences

in spore size alone cannot therefore be regarded as satisfactory grounds for maintaining species.

Confirmatory evidence of the correct identification of the conidial stage is frequently afforded by the development of the ascigerous stage (*Pleospora herbarum*) with its characteristic ascospores with seven cross-septa (cf. Mason, 1928). Isolations of the fungus from various hosts (including lettuce, tomato, flax, sisal, olive, orange, lemon) have been found almost always to form perithecia if the cultures are kept in the light. The importance of light was demonstrated by one Petri dish culture, of which a portion shaded by a label was observed



Text-fig. 3. *Macrosporium parasiticum* Thüm. Conidia and conidiophore from Thümen's material (Mycotheca univ. 667: on leaves of *Allium cepa*). × 500.



Text-fig. 4.

Text-fig. 4. Immature ascospores of *Pleospora herbarum* Rabenh. found in perithecia associated with *Stemphylium botryosum* Wallr. on the type specimen of the latter species. × 500.

not to bear perithecia, whereas these occurred plentifully in the unshaded parts. Some strains tend to develop the perithecial stage more freely than the conidial, whilst others do just the reverse, and others again form both equally readily, but the comparative ease with which both stages may be obtained in culture will probably assist very greatly in elucidating the synonymy of each.

Similar evidence of the identity of *Stemphylium botryosum* as the conidial stage of *Pleospora herbarum* is afforded by the type specimen itself. In his remarks on *Stemphylium botryosum* Wallroth mentioned the association of *Sphaeria complanata* Tode with it, and this probably refers to the scattered perithecia which are conspicuous on the type. These are similar in appearance to those of *Pleospora herbarum*. They are mostly very immature, but some contained asci (Text-fig. 4) with

dark-coloured spores, mostly divided by three transverse and some longitudinal septa, but in one ascus seven cross-septa were recognizable in two of the ascospores (though one spore had the seventh septum rather indefinite), and in the other ascospores the number of cross-septa was not ascertainable though clearly more than three. The mature spores were evidently muriform, with seven cross-septa. Thus the search for the ascigerous stage in the type material was rewarded by finding what I believe to be the immature stage of *P. herbarum*, confirming the conclusion arrived at from the conidia alone.

The synonyms of *Stemphylium botryosum*, if my conception of the specific limits is correct, will probably be comparatively numerous. No attempt has been made to list these, but the following are given, as type material of each has been examined. Those occurring on onion are evidently synonymous with *Macrosporium parasiticum* and consequently, I believe, with *Stemphylium botryosum*.

Septosporium scyphophorum Cooke & Harkness in *Grevillea*, IX, 129, (1881). [Type on *Eucalyptus globulus* in Herb. Kew. Text-fig. 5.]

Mystrosporium alliorum Berk. apud Saccardo, *Syll.* IV, 541 (1886). [Type on onion in Herb. Kew. The citation of this species in the Sylloge, *Gdnrs' Chron.* p. 192 (1878), only refers to an answer to a correspondent by M. J. Berkeley in which he says he found on onions an undescribed fungus belonging to the genus *Mystrosporium*. The species was also mentioned as occurring on onions at Culver, Exeter, by Berkeley and Broome in *Ann. Mag. nat. Hist.* Ser. 5, IX, 183, No. 1982 (1882), but without diagnosis. Saccardo's description is the first published and the species must date from then, Berkeley's name being a *nomen nudum*. Text-fig. 6.]

Macrosporium alliorum Cooke & Massee in *Grevillea*, XVI, 79, p. 80 (1888). [Type on onion in Herb. Kew. Text-fig. 7.]

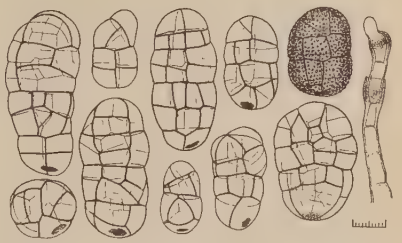
Macrosporium Symplocarpi H. & P. Sydow in *Ann. Mycol., Berl.*, XI, 65, Fig. 5 (1913). [Type on *Symplocarpus foetidus* (Fungi exot. exs. 100). Specimen in Herb. Kew. examined. This species is very like *Stemphylium botryosum* Wallr. The spores are verrucose (sometimes indistinctly), light-coloured, and the cross-walls rather more prominently marked than usual. The conidiophores are light-coloured, with a wider swelling at the apex (10 μ instead of about 8 μ), and the thickening of the wall below the apex is very marked. These differences are not regarded as of specific rank and for the present the species is placed in *S. botryosum* Wallr. Text-fig. 8.]

(?) *Thyrodochium Dracaenae* Werdermann in *Ann. Mycol., Berl.*, XXII, 189, 1 fig. (1924). [Type on *Dracaena draco* was kindly loaned to me by Dr Sydow. The species is discussed below, p. 223.]

Mason (1928) has already shown that Penzig's figure of *Macrosporium commune* Rabenh. refers to the wrong fungus. Cooke's original material of *M. Cheiranthi* Fr.β. *Betae* Cooke (Fungi Brit. Exs. 197 =

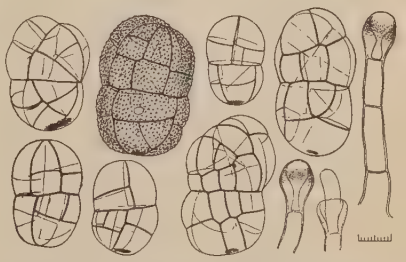
M. commune Rabenh., *Fungi Europaei*, 1360) contains an admixture of conidia of *Pleospora herbarum*, and it was conidia of this type that Penzig drew. Many identifications of *Macrosporium commune* therefore really refer to *Stemphylium botryosum*, e.g. Brefeld (1891) and Kidd & Beaumont (1924) as cited above.

Text-fig. 5. *Septosporium scyphophorum* Cooke & Harkness. Conidia and conidiophore drawn from the type specimen on *Eucalyptus* bark in Herb. Kew. × 500.



Text-fig. 7. *Macrosporium alliorum* Cooke & Massee. Conidia and conidiophore from the type specimen on onion. × 500.

Text-fig. 6. *Mystrosporium alliorum* Berk. apud Sacc. Conidia and conidiophore from the type specimen on onion. × 500.



Text-fig. 8. *Macrosporium Symplocarpi* H. & P. Sydow. Conidia and conidiophores from authentic material (Fungi exot. exs. 100) on *Symplocarpus foetidus*. × 500.

The characters of the genus *Stemphylium* Wallroth

The genus *Stemphylium*, as defined by its diagnosis, indicated by the diagnosis of its type species, and substantiated by its type specimen, is undoubtedly that named *Thyrospora* by Tehon & Daniels in 1924 and which in my paper on the foundation species of *Alternaria* and *Macrosporium* (1933) I referred to as group (*c*) comprising mostly species attributed to *Macrosporium*.

The characters which would suffice to distinguish the genus from other Phaeodictyae are (1) that the conidiophores are swollen at the apex which bears a single terminal spore (though this may be forced into a lateral position by the continued growth of the conidiophore); (2) that the growth of the conidiophore is continued through the terminal scar, the successive swellings recognizable in an old conidiophore marking the places where conidia have been borne; and (3) that the spore shape is oval or subangular, frequently constricted at the major, median transverse wall and never beaked. These characters are so clearly indicated in the diagnosis of the genus and its type species that I was able to recognize the genus implied before I knew of the existence of the Wallroth specimen.

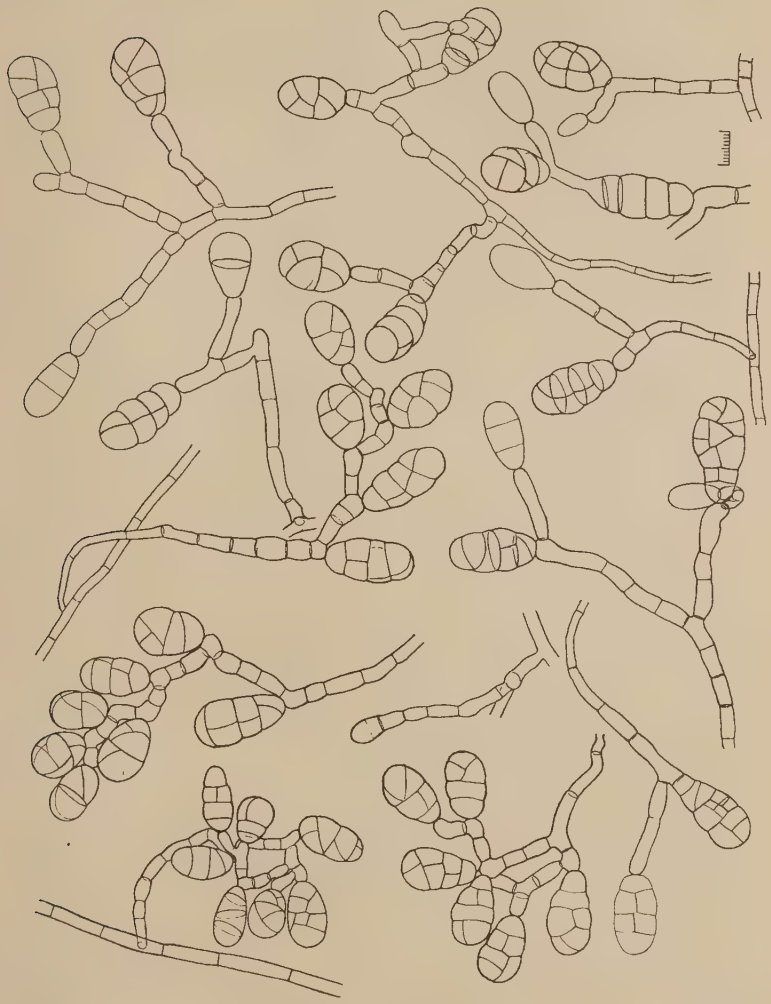
The modern conception of *Stemphylium*

Elliott in 1917 expressed the opinion that species of *Macrosporium* with sarcinaeform or globose spores should be put into *Stemphylium* as "there is nothing in the morphology of the species of this group which would exclude them from the genus". He does not enlarge on the matter, and his views have not been generally accepted, especially as *Thyrospora* was erected for the species of *Macrosporium* in question. Elliott apparently was ready to widen the conception of *Stemphylium* to include the sarcinaeform *Macrosporium* species; he did not realize that these species must be placed in *Stemphylium*, as the genus was actually founded on a fungus of this type.

Bolle (1924) based her identification of *S. botryosum* on a culture isolated and named by Oudemans, which she regarded as agreeing with Wallroth's description. In order that the reader may understand the fungus Oudemans isolated, a figure of it, drawn from an authentic culture kindly supplied by the Centraalbureau voor Schimmelcultures, is appended (Text-fig. 9).

Oudemans's fungus has no markedly swollen tips to the conidiophores, and the only resemblance it bears to the true *S. botryosum* is the shape of the conidia, but even these show no constriction at the median transverse septum. It is quite clear that Oudemans made a mistake in identifying his fungus with *S. botryosum*. Bolle interpreted *Stemphylium* in the sense of Oudemans and was convinced that it was distinct from *Macrosporium* which she would reserve for the species of the genus with sarcinaeform spores (viz. those for which Tehon and Daniels made the genus *Thyrospora*).

The present-day ideas of *Stemphylium* are generally those of Oudemans; the conidia are ovate and are borne either singly or in clusters on conidiophores which arise as branches from the mycelium. The first spore is terminal, and the conidiophore may then grow out laterally from the tip, not directly through the scar, to produce a



Text-fig. 9. *Stemphylium botryosum* sensu Oudemans. Conidiophores and conidia from cultures of Oudemans's strain. × 500.

second spore, the first being pushed into a lateral position. This process is continued until a number of conidia are produced. The scars left by fallen conidia are recognizable on the sides of the conidiophore and exactly resemble those of *Alternaria*. Sometimes the conidiophore, instead of growing out immediately below the conidium, does so lower down so that it is branched. There is no marked swelling of the tip and no thickening of the lateral walls.

Seeing that the current views of the genus differ from the original, it may be interesting to trace the development of this change.

The historical development of the current views of the genus

No notice appears to have been taken of Wallroth's genus after it was erected in 1833 until Bonorden transferred eight additional species to it in 1851. Of these the first *Stemphylium pyriforme* was originally described by Corda as *Sporidesmium pyriforme*, and his figure is reproduced on Pl. XIV, fig. 3. Corda's fungus evidently had swollen tips to the conidiophores and bore more or less ovate conidia, one of which is figured, with a marked constriction at the median, transverse wall. It is a true *Stemphylium*, though from the description and figures it cannot be identified more precisely. Bonorden (Pl. XV, fig. 10) represented the fungus with pyriform spores and only slightly swollen tips to the conidiophores.

The second species *S. polymorphum* (= *Sporidesmium polymorphum* Cda) is represented by Corda (Pl. XIV, fig. 4) without swellings to the conidiophores and with irregularly shaped spores. Bonorden (Pl. XV, fig. 11) drew it as a true *Stemphylium*, but his figure does not agree with Corda's.

The remaining six species, in the absence of authentic material, appear to be of doubtful identity. None of them belongs to Wallroth's genus, judging by the original figures and diagnoses. *S. elegans* (Pl. XIV, fig. 5) (= *Sporidesmium elegans* Cda) may possibly be congeneric with Oudemans's *S. botryosum*, and *S. rhizospermum* (Pl. XIV, fig. 6) (= *Trichaegum rhizospermum* Cda) suggests an *Epicoccum*. *S. graminis* (Pl. XIV, fig. 7) (= *Soredospora graminis* Cda) is evidently a mixture of two fungi, the dictyosporous one having spores of irregular shape. The species has been recorded from apples and from oats, but both these records referred to fungi congeneric with Oudemans's strain of *S. botryosum*. *S. dubium* (Pl. XIV, fig. 8) (= *Mystrosporium dubium* Cda) is illustrated by a rather fanciful figure, and *S. bulbotrichum* (Pl. XV, fig. 9) (= *Septosporium bulbotrichum* Cda) with spores attached by stalks to swollen bases of the conidiophores. The last of the species mentioned by Bonorden, *S. macropodium* Cda, I have been unable to trace.

The fact that Bonorden transferred such a miscellaneous batch of species to *Stemphylium* testifies that he did not rightly appreciate the genus, and this conclusion is borne out by the species *S. sphaeropodium* which was described by him in 1864. Lindau (1908, p. 220) regards this species as of doubtful identity. The description accompanied the exsiccatum, Rabenhorst's *Fungi europaei* No. 689 which was collected by Bonorden on leaves of *Arundo* [= *Phragmites*] and comparison of this from Herb. Kew. with *Napicladium arundinaceum* (Corda) Sacc. (= *Helmi*[*ntho*]*sporium arundinaceum* Corda), as represented by Briosi and Cavara: I funghi parass. 419, indicated (as Mr Mason kindly suggested to me it would) that the species are identical. The conidiophore has a swollen base but not a swollen apex while the spores (which were not present on the specimen) are pyriform with two cross-walls but no longitudinal ones. Other synonyms of this species are as follows:

[*Hadrotrichum Phragmitis* Fuck., sensu Saccardo in *Mich.* II, p. 362 (1881), teste von Höhnel, *Zbl. Bakt.* Abt. 2, LX, p. 8 (1923).]

Scolecotrichum Roumegueri Cav. 1890 in Briosi & Cavara; I funghi parass. 112 on *Phragmites communis*. [= *N. arundinaceum* (Corda) Sacc. teste von Höhnel, *loc. cit.*] Exsiccatum in Herb. I.M.I., examined.

Napicladium laxum Bubák, 1906, in *Ann. Mycol., Berl.*, IV, p. 121 (1906) on *Phragmites communis*; type Kabat & Bubák, Fungi Imperf. exs. No. 48 [= *S. Roumegueri* Cav. teste von Höhnel, *loc. cit.*].

Brachysporium Phragmitis Miyake, 1912, in *Bot. Mag., Tokyo*, XXVI, 303, p. 63, Figs. 10, 11 on *Phragmites communis*. [= *N. arundinaceum* (Corda) Sacc. testibus Shirai & Hara in *A List of Japanese Fungi*, p. 232 (1927).]

The next species to be placed in *Stemphylium* was *S. fuscescens*, a description and specimens of which were issued by Rabenhorst in 1866 in his *Fungi europaei*, II, No. 1174*d*. This exsiccatum contains masses of spores of *Pestalozzia* and a number of an *Epicoccum*. Ferraris in *Flora Italica*, p. 489 (1910) reduced the species to a variety (var. *fuscescens*) of *Stemphylium macrosporoideum*, but I was unable to find any spores resembling this species on Rabenhorst's specimens. Ferraris distinguished the variety on the ground of the warted spores but type material of *S. macrosporoideum* in Herb. Kew. has warted spores so that in any case the variety cannot stand. Furthermore, as shown later (p. 229), *S. macrosporoideum* is not a *Stemphylium* either in the sense of Wallroth or Oudemans.

In 1869 Corda's species *Sporidesmium paradoxum* was added to the genus as *Stemphylium paradoxum* by Fuckel, who issued an exsiccatum of the fungus on birch in *Fungi Rhenani* 1515. Corda's figure is very characteristic (Pl. XV, fig. 12). One of Fuckel's specimens preserved in Herb. Kew. shows a fungus with large multiseptate spores, rather irregular in outline with a smooth surface, fuscous except the end cell

which may be almost hyaline. It was difficult to determine how the spores were borne, but one showed (somewhat indistinctly) two hyphae attached to the base. These appeared to be ordinary hyphae and not specially developed conidiophores, and it is just possible that the spores may be bulbils though more material of the fungus is required for its structure to be properly investigated.

We now come to the important species *Stemphylium lanuginosum* which was described exceptionally fully by Harz in 1871, who also published a figure of the species (Pl. XV, fig. 13). This species is evidently the one upon which the current ideas of the genus are based. Harz obtained the fungus from honeycomb of a beehive affected by foulbrood, which had been placed for observation in a moist chamber. He remarks that fairly long lateral branches develop below a conidium, which again form a conidium at their apex, the same process being repeated below these branches so that a kind of cymose conidial system is formed. The conidia are stated to be unicellular at first but rapidly becoming divided by a transverse septum into two fairly equal halves; gradually turning brown it forms several transverse and longitudinal septa. The mature conidium is barely angular, oval, or rounded ovoid at both ends, light to very dark brown, 30 μ in length and 21·5 μ in breadth. This description agrees fairly well with Oudemans's *S. botryosum* (9–39 × 9–22 μ according to Bolle) but the conidia are slightly less elongated. There are no apical or nodular swellings to the conidiophores and also no median constriction in the spores. The characteristic branching of the conidiophores described by Harz occurs in Oudemans's strain whereas it has not been noticed in a number of cultures of allied species. Tentatively therefore I am inclined to consider *S. botryosum* of Oudemans as identical with *S. lanuginosum*. Saccardo renamed "*Mystrosporium lanuginosum* Harz" *Alternaria lanuginosa* in *Syll.* IV, 546 (1886), but as explained in *Syll.* XVIII, 624 (1906), the former name was a *lapsus calami* for *Mystrosporium hispidum* which should be called *Alternaria hispida* (Harz) Oud.; no such species as *Mystrosporium lanuginosum* was described.

Although the fashion set by Harz has been followed by most systematists, no doubt partly by reason of the excellent figure Harz published, there are instances where the original usage has been adhered to. Horne & Horne (1920) described the conidial stage of *Pleospora pomorum* (= *P. herbarum*) as "of the *S. pyriforme* type", and Weber, in doubt about the correct genus for his *Stemphylium Solani*, decided to follow Elliott, and his species, erected in 1930, is a good *Stemphylium* in Wallroth's sense.

Modification of the original conception of *Stemphylium* to include the current one

Under the International Rules of Botanical Nomenclature, there seems to be no alternative to retaining Wallroth's characters for the genus *Stemphylium*. To avoid the necessity of transferring the species of *Stemphylium* sensu Harz to another genus I propose that both groups should still be included in the genus (the essential character of which would be the dark-coloured, muriform, ovate or subangular spore) and that they should be termed *Eustemphylium* and *Pseudostemphylium*, respectively, the former including those species with the original characters of the genus and the latter those allied to *Stemphylium lanuginosum* Harz. Ultimately it may be necessary to transfer the *Pseudostemphylium* section to a new genus, but to do so now would probably lead to great confusion as the genus is chiefly composed of members of this group. It was hoped that *Mystrosporium* might be the proper genus for the *Pseudostemphylium* group, as Bolle regarded it as synonymous with *Stemphylium*. It was founded on *Mystrosporium dubium* (Pl. XIV, fig. 8), and neither the generic diagnosis nor the description of the single type species affords any idea of the fungus concerned. The vague characters of the genus are sufficiently manifested by the fact that it has been regarded as synonymous with *Alternaria* by Elliott, with *Stemphylium* by Bolle, and with *Macrosporium* by Shear & Clements.

It may be remarked here that De Sousa da Camara in 1930 proposed the separation of the genus *Soreymatosporium* from *Stemphylium* on the basis of its pleurogenous conidia, the latter genus being retained for those species with conidia of the acrogenous type. In both *Eustemphylium* and *Pseudostemphylium* groups the spores arise terminally and may be pushed into a lateral position if the conidiophore continues growth. In his description of *Stemphylium dendriticum*, Da Camara gives the spores as acro-pleurogenous, but his Figs. 4, 5 and 6 suggest the usual method of formation, with which the drawing in his Fig. 7 does not seem to correspond. Pleurogenous conidial formation appears to be very rare in species of *Stemphylium*, and its occurrence indeed requires confirmation.

Another genus which must be considered in connexion with *Stemphylium* is *Thyrodochium* founded by Werdermann on *T. Dracaenae* in 1924, type material of which was kindly lent me by Dr Sydow. This species has conidia and conidiophores exactly similar to *Stemphylium* Wallr., but the conidiophores are borne in a cluster on a stroma which induced Werdermann to place it in the Tuberculariaceae. But *S. botryosum* itself also occurs sometimes on a stroma, and in fact the type material of this species showed equally marked stromatic development as the type of *Thyrodochium Dracaenae*. In shape and

size the spores (Text-fig. 10) are very like *Stemphylium botryosum* Wallr. and I think that *Thyrodochium Dracaenae* is really synonymous with it. *Thyrodochium* antedates *Thyrospora* by a year, so that in any case it is extremely doubtful whether the latter genus could stand, and by interpreting *Stemphylium* as I have suggested we have a very old and presumably stable genus in which to place these species.

Text-fig. 10. *Thyrodochium Dracaenae* Werderm. Conidia and conidiophores drawn from type material on *Dracaena draco*. × 500.

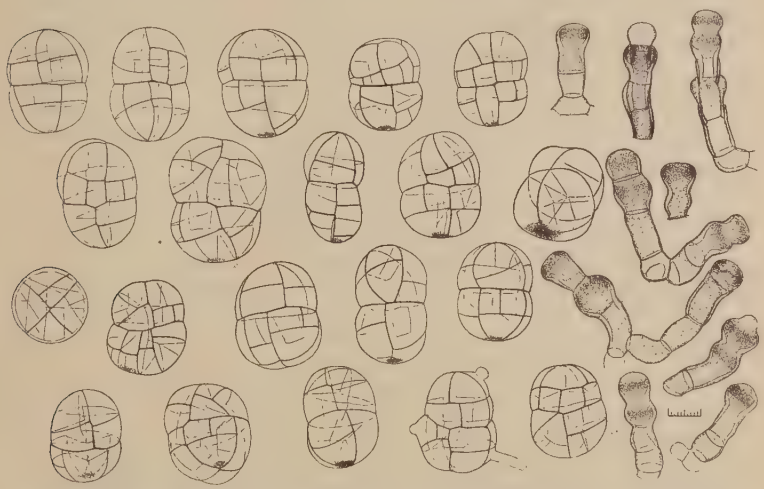
Transference of species of *Thyrospora* to *Stemphylium*

Thyrospora sarcinaeforme *(Cav.) Tehon & Daniels*

To *Eustemphylium* must be transferred the species now placed in *Thyrospora*. Of these the first is *T. sarcinaeforme*. As Bongini has recently shown, Tehon & Daniels in erecting *Thyrospora* on *Macrosporium sarcinaeforme* Cav. did not correctly identify their fungus, for it had echinulate spores whereas *M. sarcinaeforme* has smooth spores. I collected Càvara's fungus on clover at Oakley, Hants, in September, 1932, where it occurred extensively in a field, producing on the leaves dark brown, zonate spots, ranging from 1 to 8 mm. in diameter, broadly oval or circular (Pl. XV, fig. 14). The conidiophores (Text-fig. 11) occurred singly for the most part but were sometimes grouped; they projected more or less perpendicularly from the epidermis and measured from 16–50 μ long by 6–8 μ in diameter at the base and 9–12 μ at the apical swelling. Close examination of the conidiophore showed that sometimes the apical swelling or nodular segments arose from within the lower part of the hypha, through the dark outer wall of which the inner cell wall could be recognized.

Method of conidial formation. As the method of formation in *Stemphylium* is an important character detailed observations of the process in this species were made. It was found to correspond with that described by Miyabe (1889, p. 2) for *Macrosporium parasiticum*. In culture the actively growing, vegetative hypha, when about to form a conidiophore (Text-fig. 12), swells up towards the end which

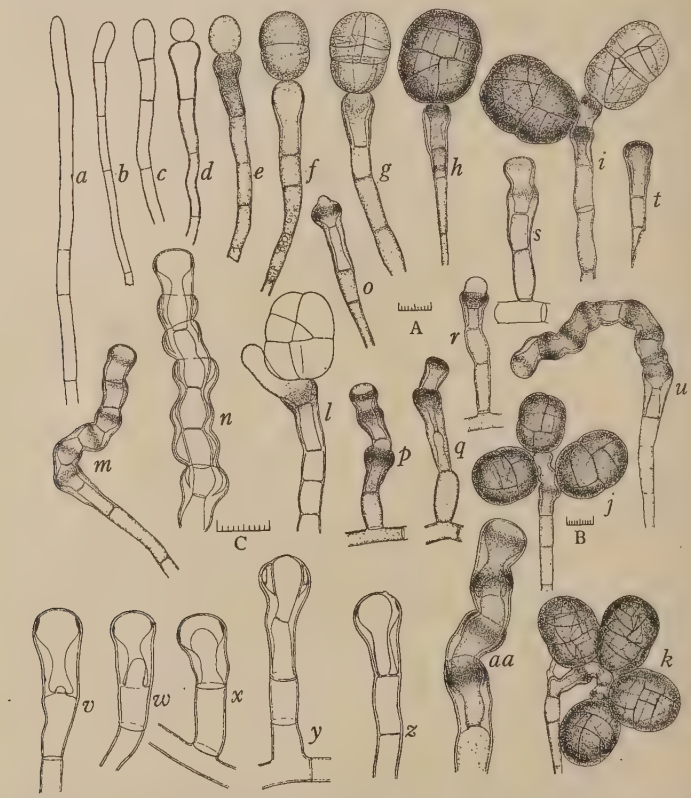
becomes somewhat club-shaped. A small, thin-walled, spherical or slightly oval, hyaline body, the young spore, is formed on its apex, which is often rather flattened, and the sides of the terminal cell of the conidiophore become slightly thickened. The immature spore increases in size, but the wall remains thin whilst at the same time the thickening of conidiophoral wall becomes more apparent. This thickening gradually increases until a well-defined greenish or hyaline inner layer is formed, chiefly in the lower part of the terminal cell and reaching its greatest thickness just below the swelling, above which it rapidly thins again so that there is no thickening visible at the apex.



Text-fig. 11. *Stemphylium sarcinaeforme* (= *Macrosporium sarcinaeforme* Cav.). Conidia and conidiophores from clover; the top three rows from material collected at Oakley, Hants, in September 1932, the bottom row from Cavara's exsiccatum, I funghi exsicc. No. 116. × 500.

When rather more than half grown the spore divides into two approximately equal cells by a transverse wall, a slight constriction being noticeable at this wall at a very early stage. Vertical, cross, and oblique walls are then formed and the spore deepens in colour as does also the conidiophore, especially at its swollen part. The mature spore is a heavy structure for the conidiophore to bear and the thickening of the sides of the latter may be on account of this. Just below the region where the spore is attached is a somewhat broad, darkened zone, suggesting in optical section a bubble of gas, whilst at the base of the conidium itself a dark "bubble" is often seen. When the spore is mature it may fall off, or the conidiophore continue

development with it still attached, forcing the spore into a lateral position. There are two methods by which the conidiophore may continue growth (*a*) simply by the growing out of the apex through



Text-fig. 12. *Stemphylium sarcinaeforme* (= *Macrosporium sarcinaeforme* Cav.) in culture, showing the development of the conidiophores and conidia. *a–h*, early stages in the formation of conidiophores and conidia. *i–k*, formation of two, three, and four conidia on single conidiophores. *l*, conidial formation within the agar and continued growth of the conidiophore. *m–u*, different types of conidiophores. *v–aa*, stages of growth of intrahyphal hyphae on the septal wall of the terminal cell of the conidiophore. Magnification, all ×500 (scale A); except *j*, *k*, *m*, *o–u*, ×approx. 400 (scale B); *n*, *v–aa*, ×800 (scale C).

the scar, or (*b*) by a new hypha growing up from the septal wall below, through the apical swelling (where it sometimes becomes swollen), and piercing through the apical scar forms a new apical

swelling. Such a hypha is thin-walled and difficult to discern when young, but with age it gradually thickens and it can be readily recognized in old conidiophores. The transverse wall from which the growth takes place may be the original basal wall of the terminal cell or a new transverse wall, formed usually where the inner thickening is greatest. These two methods are often seen in one conidiophore; with the first there is no fracture of the conidiophoral wall such as can be discerned, though sometimes with difficulty, with the second.

An explanation of the existence of the two methods may be found in the wounding of the conidiophore. Buller (1933, pp. 130–40) has shown that when a hyphal cell is wounded, the perforation in each septal wall bounding it is immediately plugged and within a short time a new hypha grows out from the plugged wall. It is quite conceivable that the spore, either in falling off or as the result of movement, may injure the conidiophore, and when this occurs a fresh hypha grows up from the septal wall below to continue the development of the conidiophore. Where no injury takes place then the growth continues from the apex uninterruptedly. It may be objected that if such an explanation is correct the two methods of conidiophore growth should occur in other fungi. As a matter of fact, apart from *Macrosporium parasiticum* they have been recorded already by Wardlaw in *Helminthosporium torulosum*, whilst I have also seen them in various species of *Alternaria* where, however, the intrahyphal hyphae are difficult to make out as there is no apical swelling to the conidiophore. Duvernoy and Maire have also described a modified intrahyphal growth of the conidiophore in *Endophragmia mirabilis*. It would not be surprising if both methods occur in a number of big-spored fungi.

The conidiophore of *Macrosporium sarcinaeforme* may continue to develop until a number of spores are formed in a cluster. The positions of the spores can often be recognized by the flattened bends in the conidiophore, but sometimes the apical swelling appears to grow out into another apical swelling without bearing a spore.

The mature conidia are ovate but with a median constriction, each half approximating to rather more than half a sphere. Sometimes the conidia are rather elongated, reaching to nearly twice as long as broad; they are much divided, olivaceous in colour but remain somewhat translucent and have a smooth surface. The point of attachment is marked by a basal scar which is very well developed and consists of a darkening of the cell wall round a small light-coloured area. In size the conidia measure $28–38 \times 18–29\,\mu$ on the host-plant and $21–36 \times 16–28\,\mu$ in culture. Cavara's measurements were $24–28 \times 12–18\,\mu$, but evidently he measured smallish, possibly immature conidia (as may be gathered from his figure), for on his exsiccatum (I funghi parass. No. 116) they were $28–31 \times 21–25\,\mu$ (Text-fig. 11). Though there is a slight divergence in spore measure-

ments between the Oakley collection and Cavara's material the general similarity of the fungi is so close as to leave no doubt of their specific identity. Through the kindness of Prof. McCallan a culture of his isolation of *M. sarcinaeforme* from red clover was received from the United States, and this agreed with the Oakley fungus. Bolle (1924, p. 68) considered that *M. sarcinaeforme* was identical with *M. parasiticum*, but the strains she regarded as *M. sarcinaeforme* were isolated from seeds of *Trifolium* and *Medicago* supplied by Dr Gentner who in 1918 stated that *Macrosporium sarcinaeforme* was the conidial stage of *Pleospora herbarum*. Both Gentner and Bolle appear to have misidentified *Macrosporium sarcinaeforme* and to have really had a strain of *Pleospora herbarum*.

The identity of the species *Macrosporium sarcinaeforme* Cavara, therefore, is clear; it evidently belongs to the *Eustemphylium* section of the genus *Stemphylium* and is accordingly renamed ***S. sarcinaeforme*** (Cav.) comb.nov., and the name *Thyrospora sarcinaeforme* (Cav.) Tehon & Daniels exd.spec. then becomes a synonym.

Turconi & Maffei (1912) erected *Macrosporium Sophorae* for a fungus causing a spotting of leaves of *Sophora japonica*. An exsiccatum of this species was issued by Pollacci in *Fungi Longobardiae*, exs. 298, and this has proved to be *Stemphylium sarcinaeforme*. The authors state that their species differs from the latter in the shape and colour of the spots and the shape and dimensions of the conidiophores and conidia. The spots may be expected to differ somewhat from those of clover but the shape and dimensions of the conidiophores and conidia agree very well with the revised diameters for *S. sarcinaeforme* given above.

Thyrospora parasitica (*Thüm.*) *Angell*

The second species to be placed in *Thyrospora* was *T. parasitica* (Thüm.) Angell, 1929. This species was originally named *Macrosporium parasiticum* Thüm. which has already been shown to be synonymous with *Stemphylium botryosum* Wallroth.

Thyrospora Solani (*Weber*) *Sawada*

The third species to be placed in *Thyrospora* was *T. Solani* described by Weber in 1930 as *Stemphylium Solani* and transferred to *Thyrospora* by Sawada in 1931. It is a true *Thyrospora* but as this genus is here treated the original name is the valid one. The species is said to have spores which are smooth when young and slightly reticulate after maturity and which measure 45–50 × 20–23 μ. The descriptions and published figures of the fungus suggest *Stemphylium botryosum* but the reticulate spore wall does not fit this species.

Other forms included in *Stemphylium* but foreign to this genus

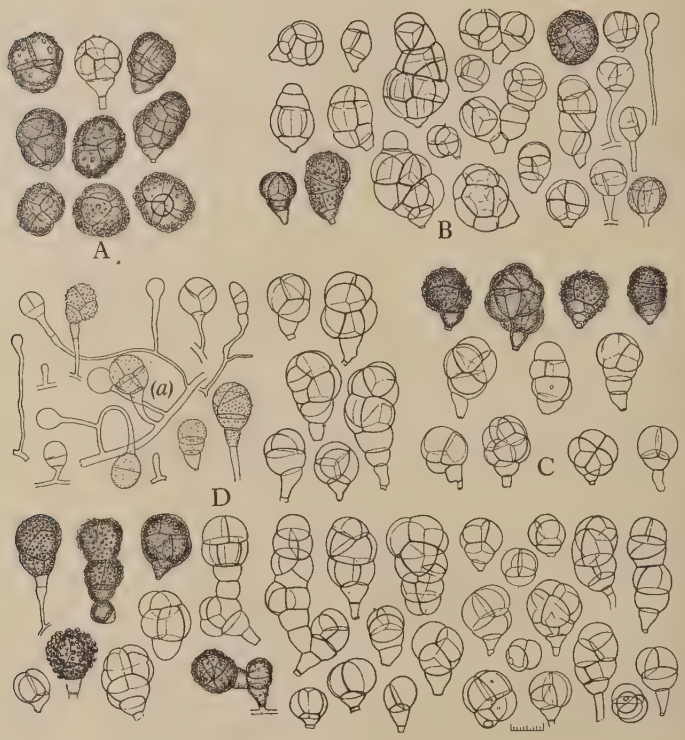
S. macrosporoideum (*Berk.*) *Sacc.*

It would be unsatisfactory to close this account of *Stemphylium* without referring to another spore form entirely distinct from the preceding ones which was introduced into this genus by Saccardo in 1886 when he transferred *Epochnium macrosporoideum* Berk. (Pl. XV, fig. 15) to the genus as *Stemphylium macrosporoideum* (*Syll.* IV, p. 519). This species was discovered on "the decorticated portions of a decayed twig apparently of *Ribes rubrum*" on which it formed a slate-black stratum. Berkeley's description is as follows: "From the tips or on very short lateral branches spring sub-globose or oval colourless transparent vesicles with a central nucleus; these by degrees are furnished with obscure septa still retaining their transparency; at length they acquire when full grown a brown hue and are from $\frac{1}{1500}$ to $\frac{1}{2000}$ of an inch in diameter. They are then in general more or less globose, divided by septa into a few lobes, which are disposed in a radiating manner like the berries of a mulberry. Occasionally the septa appear darker than the rest of the sporidia. A few are furnished with a little apicular peduncle but the greater part lose all traces of the point of attachment. I have sometimes seen one or two cells projecting from the otherwise globose sporidia and in one instance two sporidia were united by means of such a process." The twig comprising Berkeley's original specimen is preserved in Herb. Kew. but from it I could obtain only a very few spores. These agreed with the description given by Berkeley but the surface was distinctly warted on some of them.

In 1932 I found Berkeley's *Epochnium macrosporoideum* growing on the underside of damp linoleum in my house at Kew. The fungus produced an extensive growth, which, when uncontaminated with other fungi, was a beautiful lavender colour. The species readily grew in culture and the mode of development was exactly as described by Berkeley and the different stages are shown in Text-fig. 13. The so-called "apicular peduncle" is clearly formed by the somewhat conically shaped basal cell of the spore, which is seen projecting from most spores below which the stalk breaks off when the spore is shed. Sometimes there is a sort of lop-sided swelling to the "subglobose or oval vesicle" of the young spore but nothing in the form of a spiral is seen such as occurs in a related species. The spores measure $10–49 \times 9–18\,\mu$, mostly about $19 \times 13\,\mu$.

Besides Berkeley's original material, there is in Herb. Kew. a specimen labelled in Cooke's handwriting "*Stemphylium macrosporoideum* (B. & Br.) Sacc." without any indication of its origin. It

consists of the characteristically coloured growth on a piece of bark and bears a large number of spores which microscopically agree with those figured by Berkeley, especially as regards the branched spores or

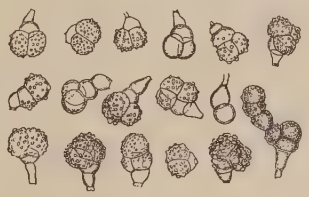


Text-fig. 13. *Acrospeira macrosporoidea* (=*Stemphylium macrosporoideum* (B. & Br.) Sacc.). A. Conidia from type material of *Epochnium macrosporoideum* B. & Br. in Herb. Kew. B. Conidia from a specimen labelled "*Stemphylium macrosporoideum* (B. & Br.) Sacc." in Cooke's handwriting in Herb. Kew. C. Conidia from a collection on linoleum in Kew, 1932. D. Conidia from an isolation from C in culture on clear maize meal and onion agars. Stages in the development of the spores are shown at (*a*). Magnification × 500.

spores united by means of a process, examples of which were not found in the type. Similar spores were obtained in culture, where they developed just above the surface of the agar. The systematic position of this species and of the two following is discussed below.

Stemphylium asperosporum Cooke & Massee

A second species of the same type as *Stemphylium macrosporoideum* is *S. asperosporum* Cooke & Massee, 1887. It was discovered on paper in London. The original specimen in Herb. Kew. agrees with the diagnosis except that the conidia themselves are about 12 μ in diameter and not "each cell" of the conidium. The development of the fungus has not been followed in culture but it evidently agrees with *S. macrosporoideum* in the way the spores are borne, the stalk cell being clearly recognizable while a few immature spores seen in the type material show that the same kind of attachment obtains [Text-fig. 14].

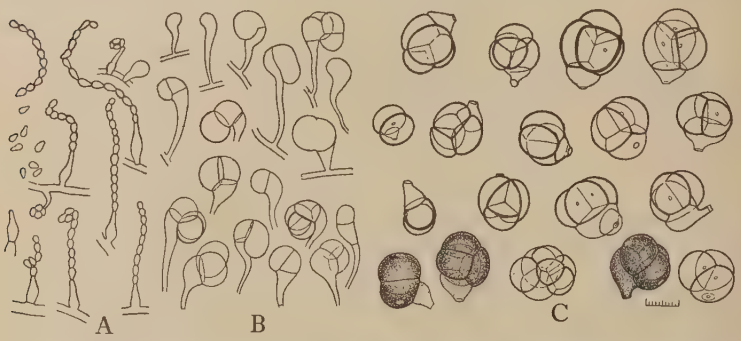


Text-fig. 14. *Acrospeira asperospora* (=*Stemphylium asperosporum* Cooke & Mass.) drawn from type material in Herb. Kew. × 500.

Stemphylium paxianum *(von Szabó) Lindau*

A third species which is allied to *Stemphylium macrosporoideum* is one received from Baarn under the name of *S. paxianum* (von Szabó) Lindau (Text-fig. 15). This species grows well in culture, forming a silver-grey colony bearing large numbers of spores. These are initiated by a swelling of the end of the hypha (or of a lateral branch), which becomes somewhat clavate but is usually more or less twisted or bent. The swelling at the end enlarges and may partly turn over to give a slight indication of a hook. The young spore is then cut off by a wall, further swelling takes place, the hook may become more marked, other walls are formed and ultimately a roughly spherical, thick-walled, dark-coloured spore is produced, divided in all planes into one to six (mostly four) cells and provided with a broadly obconical basal cell, the free end of which marks the point of attachment to the conidiophore; the broken end of the latter may remain attached to the spore-body. The surface is smooth and germ-pores can be recognized, usually one to each cell. Pores are also frequently visible in the dividing walls. The spores measure 12–25 × 10–19 μ. After careful search phialospores were found in old cultures which had been revived. These are obpyriform, hyaline, about 2–4 × 1·5–2 μ and occur in chains of up to fourteen phialospores, being abstricted in succession from a subulate basal cell borne as a branch on the mycelium.

S. paxianum was originally described as *Tetracoccosporium paxianum* in 1905. I am indebted to Dr von Szabó for the information that no type material of the species exists, but from the diagnosis and accompanying figures it is clear that the spore was divided into four cells by two vertical walls at right angles to each other. A specimen of the Baarn fungus was submitted to Dr von Szabó, who stated that it was not his species. The Baarn culture was derived in the first instance from deer dung in Belgium. So far as I am aware the species has not yet been given a name, though it appears probable that it has been taken to be *S. macrosporoideum* by various mycologists. Oudemans's isolation of the latter species preserved at the Centraalbureau, Baarn, proved to be identical with it. The descriptions of Saccardo



Text-fig. 15. *Acrospeira levis* from the culture sent to Baarn as *Stemphylium paxianum* (von Szabó) Lindau. A. Phialospores developed in a month-old culture on clear maize meal agar. B. Stages in the development of the aleuriospores. C. Mature aleuriospores. Note the pores in the cross septa and the germ pores in two of the shaded spores. Magnification × 500.

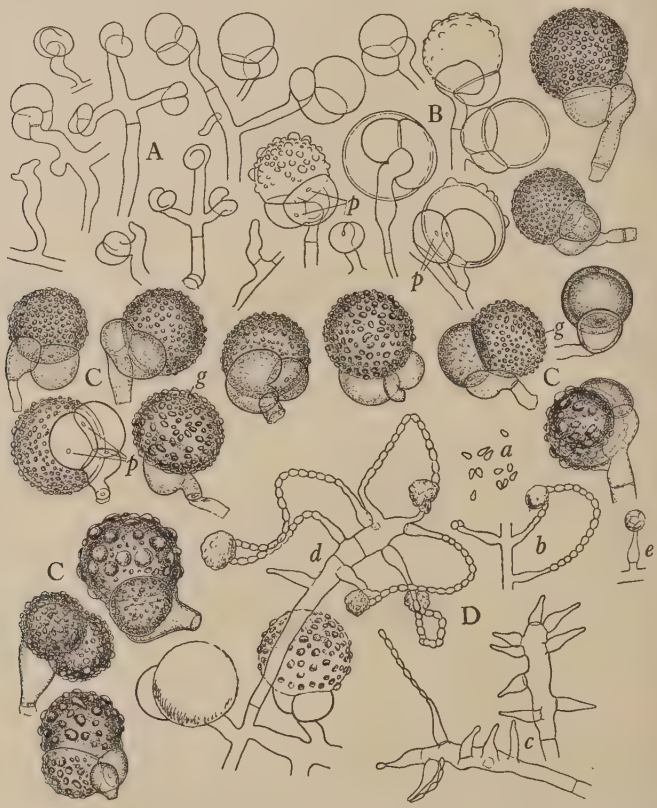
and, later, those of Lindau and Ferraris mentioned the spores of *S. macrosporoideum* as "cruciately or radially divided". Berkeley stated that the spores of his species are disposed in a radiating manner but the cruciate character is not mentioned; it may have been taken from Berkeley's figure *e*. The spores of the Baarn fungus, however, are not cruciate though those of the true *Tetracoccosporium paxianum* are and it may have been this character, erroneously attributed to *Stemphylium macrosporoideum*, which induced Lindau (1908, p. 219) to transfer *Tetracoccosporium paxianum* to *Stemphylium*.

It will probably be conceded that *S. macrosporoideum*, *S. asperosporum*, and the Baarn culture of *S. paxianum* belong to the same genus but not to *Stemphylium*. On the other hand, they have much in common with *Acrospeira*, and this genus may now be considered in this connexion.

The genus *Acrospeira* in relation to *Stemphylium macrosporoideum* and allied forms

Berkeley & Broome in 1861 erected *Acrospeira* for the remarkable fungus *A. mirabilis* found on Spanish chestnuts at Bristol. The structure of this fungus has been studied by Hotson (1912), by Mangin & Vincens (1920) who named it *Spirospora Castaneae* (erecting a new genus) and by Peyronel (1921) who discussed in detail the synonymy. The characteristic feature of the species is the spiral coiling of the young conidial primordia (Text-fig. 16). The ends of the branches of the conidiophore, usually three at first but finally numerous, swell slightly and become coiled, the coil often occurring in more than one plane. Transverse divisions, usually three, develop in the coiled portion, cutting off three cells, and the terminal one increases in size and becomes globular. The spiral twisting is so tight that the two lower cells lie closely adpressed to the large terminal cell which is warted and coloured brown. Hotson (p. 266), following Berkeley & Broome and Biffen, considers that it is the penultimate cell of the coil which enlarges as a rule to form the functional spore, but occasionally the end cell. In cultures very kindly supplied to me by Prof. Peyronel only the terminal cell was observed to do this and confirmatory evidence of this was obtained from the fully developed spore. Buller (1933, p. 86) has recently discussed the pores which occur in cross-walls of fungus hyphae. In the mature spore of *Acrospeira mirabilis* such pores can be recognized in some of the walls dividing the cells. If the enlarged cell were the central cell of the three cells constituting the young spore, then the walls between it and each of the two smaller cells should have pores, and there should be no pore in the wall between the two small cells. On the other hand, if the enlarged cell is the terminal cell of the coil, there should be a pore only in one of the walls dividing the large cell from the two smaller cells and a pore in the wall dividing the two small cells from each other. The latter alternative has been repeatedly observed and is represented in Text-fig. 16*p*, but no instance of the former has been seen. The number of cells constituting the spore may vary from two to four or more but only the terminal cell swells up; the stalk cell is usually clearly evident, sharply marked off by its brown colour from the supporting hyaline hypha. The spore is shed apparently by being broken off. A single germ pore (Text-fig. 16*g*) is often recognizable on the enlarged cell at a point diametrically opposed to the perforated cell wall dividing it from the next cell below and the single germ-tube usually develops radially from the pore (see Mangin & Vincens, Fig. 7). The straight germ-tube branches near its base, pushing the spore aside, so that the branch comes to lie in the same straight line as the original germ-tube, but growing in an opposite direction. Mangin & Vincens described

the phialospore stage of the fungus and this was readily obtained in pure culture on potato dextrose agar. The phialospores are obpyriform, borne in long chains, arising from phialids formed directly on



Text-fig. 16. *Acrospeira mirabilis* B. & Br. isolated from chestnut by Prof. Peyronel. Drawing from cultures on various media showing: A. Young stages in the formation of the aleuriospores. B. Intermediate stages. C. Fully developed aleuriospores. D. Phialospores. *a*, spores in lactic acid; *b–e*, phialospore development (from living cultures in surface view; *d* shows phialospores and aleuriospores on the same hypha). Note septal pores at *p* and germ pores at *g*. × 500

the mycelium or on the swollen end of a hypha projecting into the air.

We are now in a position to consider the relation between *Acrospeira* and *Stemphylium macrosporoideum* and allied species. In all these species

the spores consist of a number of cells united to form a muriform, globose spore, the stalk cell of which is recognizable as a more or less obconical projection. The spore does not fall from the conidiophore leaving a scar but is broken off and often the remnants of the fractured hypha remain attached. This behaviour marks off these species from *Stemphylium* as here interpreted. The method of spore development in these species, however, is not uniform; in *Acrospeira* the spore develops as a closely pressed coil; in the Baarn "*Stemphylium paxianum*" there is some suggestion of a hook but cells of the spore are formed by subdivision of the "hook" rather than by the coiling of the transversely septate spore primordium; in *S. macrosporoideum* the young spore is almost spherical and the cells arise by subdivision without any coiling, while in *S. asperosporum* it is possibly similar. Further, the phialospores of *Acrospeira mirabilis* and the Baarn "*Stemphylium paxianum*" are of the same general type; they have not been observed in the other two species. *Acrospeira* has usually been regarded as belonging to the Dematiaceae-Amerosporae (see Shear and Clements, Ferraris) but the spore clearly consists of more than one cell, and as the walls dividing the cells are oblique, it may more properly be placed in the Phaeodictyae. Hotson (p. 298) remarked on the similarity between the mature spores of *Stemphylium macrosporoideum* and *Acrospeira mirabilis* (though he regarded the spores of the latter as bulbils). Apart from the method of spore development, and also the colour of the spores, which is reddish brown in *A. mirabilis* and olivaceous in the others, there is considerable similarity between all these species and the question arises whether they are sufficiently alike to be regarded as belonging to one genus. There are two alternatives: (1) to erect a new genus for *Stemphylium macrosporoideum*, *S. asperosporum* and the Baarn "*S. paxianum*"; (2) to transfer all these species to *Acrospeira*.[1] The multiplication of genera in the present stage of systematic mycology, will, if allowed to proceed unchecked, ultimately result in a large number of monotypic genera being established, the relationships of which will remain obscure. A better plan is to group more or less similar species round known generic types, leaving the limits of the genera to become manifest in course of time. Furthermore, many of the genera are not properly understood and to add to their number

[1] Montagne in *Ann. Sci. nat. Bot.* Sér. IV, viii, 299 (1857), erected a genus *Acrospira* on the single species *A. Crouanii* found on *Angelica sylvestris*. Saccardo remarks (*Syll.* XIV, p. 1056) that Montagne's genus is related to, but distinct from, *Acrospeira* B. & Br., whilst Clements and Shear regard it as a doubtful genus. Berkeley briefly referred to *A. mirabilis* in his *Introduction to Cryptogamic Botany* (p. 305 and Fig. 96*a*), 1857, but this description probably cannot pass as a valid generic diagnosis. Furthermore there is some doubt whether the *Introduction* was published earlier in 1857 than Montagne's genus, or not. It is possible that the name *Acrospeira* B. & Br. may prove to be untenable, but as it is so well established I think it best to adhere to it for the present, especially as the spelling is different from Montagne's.

without a very real necessity is to be deprecated. The chief objection to the second alternative is that the characteristic method of spore development in *A. mirabilis* is not followed by the other species but the Baarn "*Stemphylium paxianum*" forms a connecting link which greatly strengthens the case for uniting all the species in the one genus. Therefore, while admittedly widening the conception of *Acrospeira* rather more than some may care to do, I propose to adopt what seems to me to be the lesser of two evils and to transfer the species *Stemphylium macrosporoideum* and *S. asperosporum* to *Acrospeira* as ***A. macrosporoidea*** (Berke) comb.nov. and ***A. asperospora*** (Cooke & Massee) comb.nov. respectively and to name the Baarn culture of "*Stemphylium paxianum*" *Acrospeira levis*. This, at any rate, will be more satisfactory than leaving these species in *Stemphylium*, where they are manifestly out of place.

The diagnosis of *Acrospeira levis*[1] is as follows:

Acrospeira levis *sp.nov.*

Hyphis septatis, hyalinis, 3 μ crassis, numerosissimas aleuriosporas gerentibus, et colonias argenteas cinereas formantibus.

Aleuriosporis solitariis, hyphis principibus, vel ramis brevibus insidentibus, initio clavatis, dein apice turgescentibus, sinuatis, et aliquando recurvatis, in 2–6 (saepe 4) loculos clathratos partitis, fere globosis, loculo inferiori obconico praeditis, 12–25 × 10–19 μ; episporio levi, crasso, fuligineo ad septa constricto.

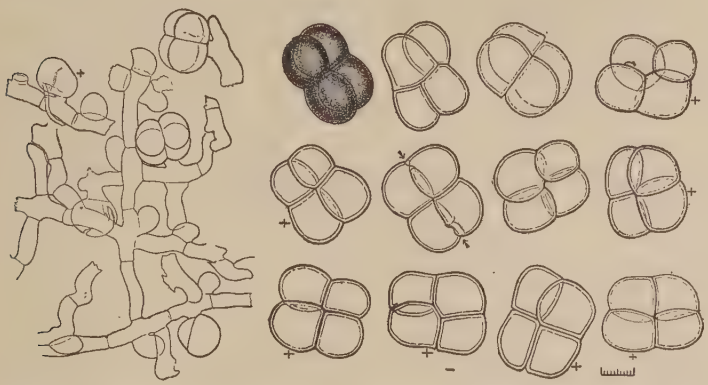
Phialidis raris, hyalinis, solitariis, subulatis, prope basim 1 septatis, 6–11 × 2–3·5 μ; phialosporis in catenulas (2–14 sporas) vel mucosa capitula abstrictis, continuis, hyalinis, obpyriformibus, 2–4 × 1·5–2 μ.

Stemphylium quadratum (*Cooke*) *Sacc.*

Finally the species *S. quadratum* needs to be considered. Originally described as *Epochnium quadratum* by Cooke in 1883, it was renamed *Stemphylium quadratum* by Saccardo in 1886 (*Syll.* IV, 521), and original material of Cooke's preserved in Herb. Kew. shows thick-walled, fragile, very dark-coloured spores of four cells arranged mostly cruciately (Text-fig. 17). From the material it is difficult to make out how the spores are borne but they seem to be attached near to the junction of the vertical walls; and to arise as lateral swellings on the mycelium. Such a spore structure cannot be included in *Stemphylium* as here revised. The genus *Tetracoccosporium* from the original description and figure (as mentioned on p. 232 no type material exists) was evidently based on a fungus with similar spores and Prof. Dr von Szabó, who kindly examined a drawing of the spores of *Epochnium quadratum* Cooke (Text-fig. 17) was of opinion that the latter species

[1] I am indebted to Mr E. W. Mason for help with the Latin.

was closely related to *Tetracoccosporium paxianum*. The spore measurements, however, are larger and I accordingly adopt the genus *Tetracoccosporium* and transfer *Stemphylium quadratum* to it as ***Tetracoccosporium quadratum*** (Cooke) comb.nov., a repetitive name it is possible to avoid.



Text-fig. 17. *Tetracoccosporium quadratum* (=*Stemphylium quadratum* (Cooke) Sacc.) drawn from type material of *Epochnium quadratum* Cooke on *Fraxinus* (labelled No. 3338, not 3388 as in *Grevillea*) in Herb. Kew. except spores indicated by +, which are from the authentic exsiccatum Rav. Amer. Fungi 773. A. Showing the formation of spores on the superficial mycelium. B. Mature spores. Fractures of the wall of one spore are indicated by arrows. Magnification × 500.

REFERENCES

Angell, H. R. (1929). "Purple blotch of onion (*Macrosporium porri* Ell.)." *J. agric. Res.* xxxviii, 9, 471.

Berkeley, M. J. (1838). "Notices of British fungi. 3. *Macrosporium sarcinula*." *Ann. Mag. nat. Hist.* i, 261, pl. viii, fig. 10.

—— (1838). "Notices of British fungi. 131. *Epochnium macrosporoideum*." *Ann. Mag. nat. Hist.* i, 263, pl. viii. fig. 14.

—— (1857). *Introduction to Cryptogamic Botany*, p. 305, fig. 69*a*.

Berkeley, M. J. & Broome, C. E. (1861). "Notices of British fungi. 952. *Acrospeira mirabilis*." *Ann. Mag. nat. Hist.* Ser. iii, vii, 449.

Biffen, R. H. (1903).

Bolle, P. C. (1924). "Die durch Schwärzepilze (Phaeodictyae) erzeugten Pflanzenkrankheiten." *Meded. phytopath. Lab. Willie Commelin Scholten*, vii.

Bongini, V. (1931). "Sur una vaiolatura del trifoglio e dell' erba medica." *La Difesa delle Piante*, ix, 4, 1–3.

Bonorden, H. F. (1851). *Handbuch der allgemeinen Mykologie*, 83, Figs. 73, 74.

—— (1864). *Hedwigia*, iii, 4, 74.

Brefeld (1891). *Untersuchungen*, x, 227, pl. VII, fig. 72.

Buller, A. H. R. (1933). *Researches on Fungi*, v.

Cooke, M. C. (1883). "New American Fungi." *Grevillea*, xii, 33.

Cooke, M. C. & Massee, G. apud Cooke, M. C. (1887), in "New British fungi", *Grevillea*, xvi, 11.

Corda, J. A. C. (1837). "*Mystrosporium dubium.*" *Icon. fung.*, I, 12, Fig. 174.
—— (1837). "*Septosporium bulbotrichum.*" *Icon. fung.*, I, 12, Fig. 176.
—— (1837). "*Soredospora graminis.*" *Icon. fung.*, I, 12, Fig. 173.
—— (1837). "*Sporidesmium elegans.*" *Icon. fung.*, I, 7, Fig. 120.
—— (1837). "*Sporidesmium polymorphum.*" *Icon. fung.*, I, 7, Fig. 119.
—— (1837). "*Sporidesmium pyriforme.*" *Icon. fung.*, I, 7, Fig. 116.
—— (1837). "*Trichaegum rhizospermum.*" *Icon. fung.*, I, 12, Fig. 217.
—— (1838). "*Sporidesmium paradoxum.*" *Icon. fung.*, II, 6, fig. 28.
De Sousa da Camara (1930). *Proposta de divisão do genero* Stemphylium *Wallr. fungo da ordem das* Hyphales (Mart.) *em Sacc. et Trav.* 21 pp., 8 figs. Lisbon: Empresa do Anuario Comercial.
Duvernoy, A. & Maire, R. (1920). "Une nouvelle Dématiée à conidies pseudo-endogènes." *Bull. Soc. mycol. Fr.*, XXXVI, 86–9, 1 fig.
Elliott, J. A. (1917). "Taxonomic characters of the genera *Alternaria* and *Macrosporium.*" *Amer. J. Bot.* IV, 439–76, 2 pl., 6 figs.
Ellis, M. (1931). "Some experimental studies on *Pleospora herbarum* (Pers.) Rabenh." *Trans. Brit. mycol. Soc.* XVI, 102–14, Pl. IV.
Ferraris, T. (1910). *Flora italica cryptogama*, p. 489.
Fuckel, L. (1869). In *Symb. myc.* p. 356.
Gentner, G. (1918). "Über durch *Macrosporium sarciniforme* Cav. hervorgerufene Erkrankungen der Luzerne und des Klees." *Prakt. Blätter f. Pflanzenbau und Pflanzenschutz*, Heft 9/10.
Gibelli, G. & Griffini, L. (1872). "Sul polimorfismo della Pleospora herbarum Tul." *Lab. Bot. crit. Pavia*, 40 pp., 9 pl.
Hanzawa, J. (1915). "Fusarium Cepae, ein neuer Zwiebelpilz Japans, sowie einige andere Pilze an Zwiebelpflanzen." *Mycol. Zbl.* V, 4–13.
Harz, C. O. (1871). "Einige neue Hyphomyceten Berlin's und Wien's nebst Beiträgen zur Systematik derselben." In *Bull. Soc. Impér. Moscou*, XLIV, I, 132, Pl. III, fig. 1.
Horne, A. S. & Horne, E. V. (1920). "On the 'spotting' of apples in Great Britain." *Ann. appl. Biol.* VII, 183–201.
Hotson, J. W. (1912). "Culture studies of fungi producing bulbils and similar propagative bodies." *Proc. Amer. Acad. Arts Sci.* XLVIII, 8, 227–306.
Kidd, M. N. & Beaumont, A. (1924). "Apple rot fungi in storage." *Trans. Brit. mycol. Soc.* X, 98–118.
Lindau, G. (1908). In *Krypt. Fl.* I, Abt. IX, 107–368.
Machacek, J. E. (1929). "The stem rot of onions." *Twenty-first Ann. Rep. Quebec Soc. Prot. Plants*, 1928–9, 58–64, 3 figs.
Mangin, L. & Vincens, F. (1920). "Sur un nouveau genre d'Adelomycètes, le *Spirospora castaneae* n.sp." *Bull. Soc. mycol. Fr.* XXXVI, 89–97, 7 figs.
Mason, E. W. (1928). *Annotated account of fungi received at the Imperial Bureau of Mycology*, List II, Fasc. 1, 13 and 23.
Miyabe, K. (1889). "On the life history of *Macrosporium parasiticum* Thüm." *Ann. Bot., Lond.*, III, 1–26, 2 pl.
Peyronel, B. (1921). "Sur l'identité du *Spirospora Castaneae* Mangin et Vincens et du *Stephanoma italicum* Sacc. et Trav. avec *l'Acrospeira mirabilis* B. & Br." *Bull. Soc. mycol. Fr.* XXXVII, 56–61.
Prillieux & Delacroix (1893). "Maladie de l'ail produite par le *Macrosporium parasiticum* Thüm." *Bull. Soc. mycol. Fr.* IX, 201–2.
Sawada, K. (1931). "Descriptive catalogue of the Formosan fungi. Part V." *Rep. Govt. Res. Inst. Formosa*, LI, 123.
Tehon, L. R. & Daniels, E. (1925). "A note on the brown leaf-spot of alfalfa." *Phytopathology*, XV, 714–19, fig. 1.
Teodoro, N. G. (1923). "A study of a *Macrosporium* disease of onions." *Philippine Agric. Rev.* XVI, 4, 233–80, 20 pl.
Tulasne, L. R. & C. (1863). *Selecta carpologia fungorum*, II, 247 (Grove's translation), Pl. XXXII.
Turconi, M. & Maffei, L. (1912*a*). *R.C. Accad. Lincei*, ser. 5ª, XXI, 247.

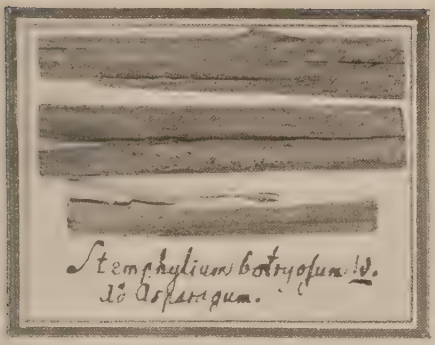


Fig. 1

Fig. 2

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Fig. 6

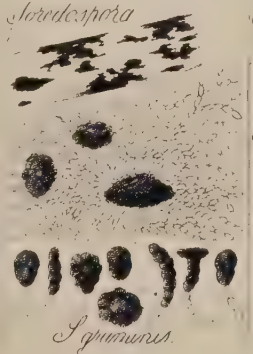

Fig. 7

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Fig. 10

Fig. 11

Fig. 12

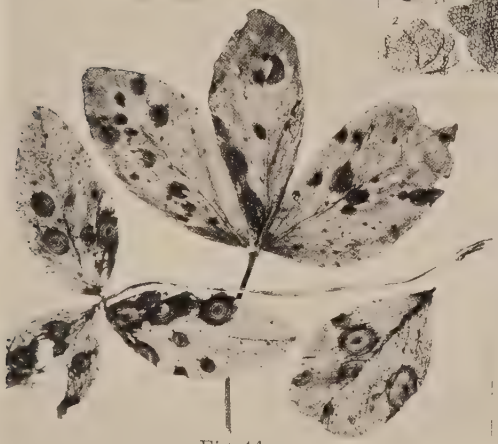

Fig. 14

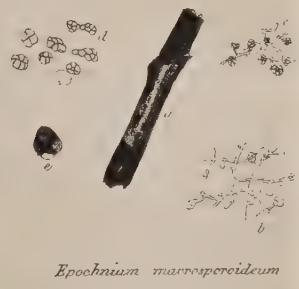

Fig. 15

Turconi, M. & Maffei, L. (1912*b*). *Atti Ist. Bot. di Pavia*, Ser. II, XV, 146, pl. XV, figs. 5–8.
Verwoerd, L. & Du Plessis, S. J. (1931). *S. Afr. J. Sci.* XXVIII, 294.
Von Szabó, Z. (1905). "Über eine neue Hyphomyceten-Gattung." *Hedwigia*, XLIV, 77, 1 fig.
Wallroth, F. G. (1833). *Flora cryptogamica germaniae*, II, 300.
Wardlaw, C. W. (1932). "Banana diseases. 4. Observations on 'Black Tip' Disease. *Helminthosporium torulosum* (Syd.) Ashby." *Trop. Agriculture, Trin.* IX, 1, 3–6, 36 figs.
Weber, G. F. (1930). *Phytopathology*, XX, 6, 516.
Werdermann, E. (1924). In Sydow, H. & Werdermann, E. "Über einige neue oder interessante Pilze der kanarischen Inseln." *Ann. Mycol., Berl.*, XXII, 189, 1 fig.
Wiltshire, S. P. (1933). "The foundation species of *Alternaria* and *Macrosporium*." *Trans. Brit. mycol. Soc.* XVIII, 135–60, 3 pl., 6 figs.

EXPLANATION OF PLATES XIV AND XV

Plate XIV

Fig. 1. *Stemphylium botryosum* Wallr. Type specimen. Natural size.
Fig. 2. *Macrosporium sarcinula* Berk. Berkeley's original figure.
Fig. 3. *Stemphylium pyriforme* (Cda) Bon. (=*Sporidesmium pyriforme* Cda).
Fig. 4. *Stemphylium polymorphum* (Cda) Bon. (=*Sporidesmium polymorphum* Cda).
Fig. 5. *Stemphylium elegans* (Cda) Bon. (=*Sporidesmium elegans* Cda).
Fig. 6. *Stemphylium rhizospermum* (Cda) Bon. (=*Trichaegum rhizospermum* Cda).
Fig. 7. *Stemphylium graminis* (Cda) Bon. (=*Soredospora graminis* Cda).
Fig. 8. *Stemphylium dubium* (Cda) Bon. (=*Mystrosporium dubium* Cda).

Figs. 3–8. Corda's original figures.

Plate XV

Fig. 9. *Stemphylium bulbotrichum* (Cda) Bon. (=*Septosporium bulbotrichum* Cda). Corda's original figure.
Fig. 10. *Stemphylium pyriforme*. Bonorden's figure.
Fig. 11. *Stemphylium polymorphum*. Bonorden's figure.
Fig. 12. *Stemphylium paradoxum* (Cda) Fuck. (=*Sporidesmium paradoxum* Cda). Corda's original figure.
Fig. 13. *Stemphylium lanuginosum* Harz. Harz's figure.
Fig. 14. *Stemphylium sarcinaeforme* (=*Macrosporium sarcinaeforme* Cav.) on clover leaves collected at Oakley, Hants., in September, 1932. Natural size.
Fig. 15. *Acrospeira macrosporoidea* (=*Epochnium macrosporoideum* Berk.). Berkeley's original figure.

UROCYSTIS SOROSPORIOIDES, A NEW RECORD FOR INDIA

By B. B. MUNDKUR
Imperial Institute of Agricultural Research, Pusa, India

(With Plate XVI)

Leaves of a perennial species of *Delphinium* showing swellings on the blade and petiole were collected at Simla in July 1935. The species was either *D. denudatum* Wall. or *D. vestitum* Wall., but this could not be ascertained with certainty for the plants did not bear flowers at the time. Microscopic examination showed that the swellings were the pustules caused by a species of *Urocystis*.

In cross-sections the diseased parts of the blade or the petiole show an erumpent circular form (Plate XVI, figs. 1, 2, 3), the upper and lower tissues being arched outwards. The cells of the ventral side of the leaf-blade are elongated and the mesophyll is replaced by a nutrient mycelium and this, later, is apparently converted into spore masses.

When seen in mass the spores have a black appearance but the sori whilst still covered by the epidermis are greyish. The spore-balls are round, oblong or obtuse, compact and opaque, 19–51 × 24–61 μ in diameter with an average of 29 × 38 μ and consist of three to seven main fertile cells surrounded by a layer of light-coloured secondary sterile cells. The fertile cells are spherical or hemispherical, 11–16 μ in diameter, dark brown with smooth epispores. The secondary cells are hemispherical, 8–12 μ in diameter with yellowish brown, subhyaline epispores. They project slightly beyond the periphery of the spore-balls and are uniformly distributed so that the spore-balls have a fairly smooth contour. Spore-balls that are not fully mature are not always completely covered by the layer of sterile cells.

Three leaf smuts belonging to the genus *Urocystis* are known to attack members of the family Ranunculaceae. None of these has, however, been recorded for India. Of these *U. Anemones* (Pers.) Wint. has, according to Clinton (1904), spore-balls that are not completely surrounded by the secondary cells. The number of fertile cells is never more than four, while the size of the pustules is also much smaller than that of the other two smuts. *U. carcinodes* (B. & C.) de Waldh. rarely attacks the leaf-blades, according to the same authority, and is confined to the midrib, petiole, and stem. *U. sorosporioides* Koernicke,

the third smut attacking this family, has large sori and correspondingly large spore-balls. These latter have several fertile cells as compared with *U. Anemones* and the covering of the sterile cells is complete when mature. It attacks both the leaf-blades and petioles and causes no unusual distortion of the host. In Europe and America *U. sorosporioides* has been reported on the genus *Delphinium*, while the other two smuts have not been known to occur on this genus.

The Simla fungus agrees closely with this smut. When the spore-balls from Sydows exsicc. (No. 375) of *U. sorosporioides* were compared with those from the Simla smut, they were hardly distinguishable from them. The comparative measurements are given in Table I.

Table I. *Comparative spore-ball and spore measurements of* Urocystis sorosporioides

	Winter (1884)	Clinton (1904)	Lindau (1912)	Mundkur
	μ	μ	μ	μ
Spore-balls	22–44	30–60	22–48 × 15–31	24–61 × 19–51
Fertile cells	12–17	13–17	11–17	11–16
Sterile cells	—	8–15	7–12	8–12

The measurements are in agreement to a considerable extent. The number of fertile cells in the Indian specimen is three to seven and this is in accord with the number given by the other investigators.

In the genus *Urocystis* and the older genus *Tuburcinia* the spore—more commonly called the spore-ball—is not a single cell but a globose ball consisting of a number of cells permanently bound together. In *Tuburcinia* all of these are capable of germination while in *Urocystis* only the central cells are fertile, the peripheral ones being sterile. Liro (1922), however, maintains that no such distinction exists and that a covering layer of sterile cells is common to all these species. He therefore suggests that the two genera should be merged. But Brefeld (1895), who succeeded in germinating the spore-balls of a *Tuburcinia* (*T. primulicola* Brefeld), found that the peripheral cells did germinate in large numbers and that there were no sterile cells outside of those germinated. In the spore-balls of *Urocystis*, however, there was always a persistent layer of sterile cells. As the spore-balls of only a single species of *Tuburcinia* and of a few species of *Urocystis* have so far been germinated, until the germination of the spore-balls of more of these has been studied and until there is some concord among mycologists as to the constancy of the sterile layer of covering cells, it is better to retain the genus *Urocystis*.

The smut collected at Simla on the leaves of *Delphinium* is therefore *Urocystis sorosporioides* Koernicke. Leaves of a *Delphinium* sp. collected at Chakratha near Dehra Dun and brought to Pusa for identification by Dr K. Bagchee were also found to be attacked by this same smut.

Summary

A leaf smut on the leaves and petioles of a species of *Delphinium* collected at Simla in July 1935 has been identified as *Urocystis sorosporioides* Koernicke. This is a first record of this fungus for India.

REFERENCES

Brefeld, O. (1895). *Untersuch. Gesam. Mykol.* xii, 180, Plate XI.

Clinton, G. P. (1904) "North American Ustilagineae." *Proc. Boston Soc. nat. Hist.* xxxi, 450.

Lindau, G. (1912). *Kryptogamenflora der Mark Brandenburg*, v *a*, 58–9.

Liro, J. I. (1922). *Ann. Univ. Fenn. Aboensis*, Ser. A.T. i, 1, 153. Turku (Original not seen).

Winter, G. (1884). Rabenhorst's *Kryptogamenflora*, i, 124.

EXPLANATION OF PLATE XVI

Fig. 1. Leaf-blade of *Delphinium* sp. showing large sori caused by *U. sorosporioides*.
Fig. 2. Petiole showing erumpent pustules of the same smut.
Fig. 3. Cross section of the petiole showing sorus and the spore-balls of *U. sorosporioides*. × 50.

Fig. 1

Fig. 2

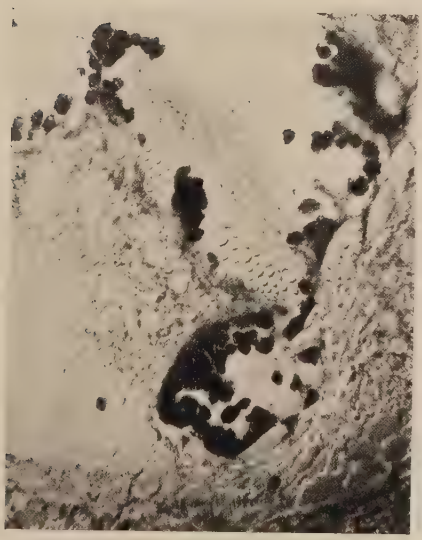

Fig. 3

BRITISH HYPOCREALES

By T. PETCH

(With 39 Text-figures)

The Hypocreales constitute one of the families of the order Pyrenomycetae, ascigerous fungi in which the asci are contained in perithecia, globose, pear-shaped, or flask-shaped receptacles, furnished with a definite wall. They are distinguished from other Pyrenomycetae by the colour and consistency of their perithecia, which are brightly coloured, usually red or yellow, not black, and soft and fleshy, or membranous, never carbonaceous. The perithecia may be free and separate from one another (Nectriaceae), or they may be embedded in a brightly coloured fleshy mass, known as a stroma (Hypocreaceae). Many of them have a conidial stage which belongs to one or other of the genera of Hyphomycetae, e.g. *Fusarium*, *Isaria*, *Tubercularia*, *Dendrodochium*, etc. Much work remains to be done in the determination of the conidial stages of the various species.

The family includes several plant pathogens of prime importance. Among these are *Dialonectria galligena*, the cause of "canker" in apple trees, and *Gibberella Zeae*, the cause of "scab" of wheat and maize. It also includes a number of fungi, formerly classed together as *Hypomyces*, which are parasitic on Basidiomycetae, and the fungi, known as *Cordyceps*, which are parasitic on insects.

No complete account of the British Hypocreales has been published since the issue in 1871 of Cooke's *Handbook of British Fungi*, in which he enumerated 56 species. Since then, many other species have been added to the British list in scattered records, often by name only, so that, unless a mycologist has access to a well-equipped mycological library, he is unable to ascertain what they indicate. Moreover, on the continent of Europe and in America, intensive researches on this group by eminent mycologists, particularly by von Höhnel and Weese, have extended considerably our knowledge of the family, and have entailed numerous corrections and alterations both in nomenclature and classification, most of which work is inaccessible to British mycologists in general. In these circumstances, the need of a new list of British Hypocreales became urgent, and the present revision was undertaken, by request, with the object of bringing an up-to-date list within the reach of working mycologists, and providing them with a means of identification of the species. It may be noted that, owing to the lack of such a list, several important plant pathogens have become generally known by names which really belong to saprophytic species.

Modern genera have been adopted wherever possible, in the belief that identification is facilitated by division into smaller groups. In the genus *Nectria*, the largest in the family, Saccardo's subdivision has been followed, though it has not been permissible to use his names in all cases. Cooke, in *Grevillea*, XII, raised some of Saccardo's subgeneric names to generic rank, and established the division of the genus *Nectria* into species on a fleshy stroma, *Nectria*, and non-stromatic species, *Dialonectria* (Greek, *dialuo*, to separate). Seaver, in *Mycologia*, I (1909), 42, though maintaining Cooke's division, transferred the name *Nectria* to Cooke's *Dialonectria* and proposed a new name, *Creonectria*, for Cooke's *Nectria*. Seaver's alteration, however, was based on a misapprehension and cannot be accepted.

Further extensive changes have been made in the genus *Hypomyces*, which, as instituted by Tulasne, was a biological genus, including those species which are parasitic on Basidiomycetae. Its constituent species have been split off at different times by different authors, and the British species now stand in four genera.

Reasons for rejecting several names and reducing others to synonymy have been published in the *Journal of Botany*, LXXIII (1935), 184–92, 217–24; LXXIV (1936), 185–93; LXXV (1937), 217–31. A few species remain doubtful, as no specimens are known; in such cases, the original description has been quoted. Although many of the older names have had to be discarded, the list now contains 124 species distributed in 41 genera.

I tender my thanks to Mr J. Ramsbottom, Keeper of Botany, British Museum (Natural History), and to Miss E. M. Wakefield, Royal Botanic Gardens, Kew, for their assistance in the examination of the Hypocreales in those herbaria, and to Dr C. G. C. Chesters, Botanical Department, Birmingham University, for similar assistance as regards the Plowright Herbarium.

HYPOCREALES

Perithecia bright-coloured, red, yellow, violet, or pallid, opening by a circular pore (ostiolum), immersed in the host, or superficial, separate, scattered, or caespitose on a superficial stroma, or embedded in a superficial or immersed stroma; perithecial wall membranous or fleshy, never carbonaceous; stroma, when present, bright coloured, fleshy, more or less soft, or byssoid.

Family 1. NECTRIACEAE

Perithecia separate, immersed in the host or superficial, or crowded on a superficial fleshy and parenchymatous stroma, or on a byssoid subiculum.

Family 2. HYPOCREACEAE

Perithecia immersed in a stroma, which is bright coloured, fleshy and parenchymatous, superficial or immersed in the host.

NECTRIACEAE

A. Ascospores continuous, hyaline, not filiform.

Perithecia immersed in the host, ascospores oval — *Hyponectria*
Perithecia immersed in the host, ascospores spherical — *Battarrina*
Perithecia superficial, on a continuous byssoid subiculum — *Byssonectria*
Perithecia superficial, without a continuous subiculum or stroma — *Pseudonectria*

B. Ascospores continuous, fuscous, dark brown or black.

Perithecia superficial, with a long beak, or with setae round the ostiolum — *Melanospora*
Perithecia superficial, without a beak, or setae round the ostiolum — *Sphaeroderma*

C. Ascospores one-septate, hyaline, not ciliate.

Perithecia caespitose
- on an erumpent or superficial stroma — *Nectria*
- at the base of a *Stilbella* conidial stage — *Sphaerostilbe*

Perithecia superficial, scattered or crowded
- without a continuous subiculum
  - perithecia smooth — *Dialonectria*
  - perithecia hairy — *Lasionectria*
  - perithecia bearing long triangular processes — *Neohenningsia*
- on a continuous byssoid subiculum
  - ascospores more or less obtuse — *Hyphonectria*
  - ascospores apiculate — *Hypomyces*
  - ascospores unequally septate — *Apiocrea*
  - ascospores dividing into two — *Protocrea*

Perithecia immersed in the host, then erumpent — *Nectriella*

D. Ascospores one-septate, hyaline, ciliate.

Ascospores with a cilium at each end — *Rhynchonectria*

E. Ascospores one-septate, brown.

Perithecia superficial — *Letendraea*

F. Ascospores oblong, fusoid, or cylindric, two- or more septate.

Perithecia superficial, without apical teeth, ascospores not ciliate
- wall red, yellow or pallid — *Calonectria*
- wall violet or blue by transmitted light — *Gibberella*

Perithecia superficial, with spreading teeth at the apex — *Actiniopsis*

Perithecia superficial, ascospore attenuated into a seta at each end *Paranectria*
Perithecia immersed, hyaline, ostiolum papillate *Cesatiella*
ostiolum long-beaked *Orcadia*

G. Ascospores filiform, or elongated fusoid, hyaline.
Perithecia superficial
smooth; ascospores filiform, continuous *Barya*
smooth; ascospores multiseptate, not dividing *Ophionectria*
hairy; ascospores multiseptate, not dividing *Trichonectria*
ascospores filiform, multiseptate, dividing into part-spores *Torrubiella*
Perithecia immersed, hyaline; ascospores multiseptate *Trailia*

H. Ascospores muriform, hyaline.
Perithecia as in *Nectria* *Pleonectria*

HYPOCREACEAE

A. Ascospores hyaline, continuous, not filiform.
Stroma immersed in leaves *Polystigma*
Stroma tomentose, partly immersed in dung *Selinia*

B. Ascospores hyaline or coloured, one-septate.
Ascospores not dividing into two, hyaline *Hypocreopsis*
Ascospores dividing into two, hyaline, stroma erect *Podostroma*
hyaline, stroma horizontal *Hypocrea*
coloured, stroma horizontal *Chromocrea*

C. Ascospores filiform, or elongated.
Stroma encrusting; ascospores multiseptate *Epichloë*
Stroma conical; ascospores multiseptate *Oomyces*
Stroma stalked; ascospores multiseptate, dividing in the ascus *Cordyceps*
ascospores multiseptate, not dividing *Ophiocordyceps*
ascospores continuous *Claviceps*

NECTRIACEAE

HYPONECTRIA Sacc. in *Michelia*, I (1878), 250

Perithecia separate, immersed in the tissues of the host, without a stroma, soft, light-coloured; asci eight-spored; ascospores hyaline, continuous, oval.

Hyponectria Buxi (Desm.) Sacc. in *Michelia*, I (1878), 250; *Sphaeria Buxi* Desm. in *Ann. Sci. Nat.* ser. 2, XIX (1843), 354; *Sphaerella Buxi* (Desm.) Fuckel, *Symb. Mycol.* (1869), 100; *Sphaerella Buxi* (DC.) Cooke (in part), *Handbook* (1871), 922; *Sphaerella Buxi* (Desm.)

Auersw., *Syn. Pyrenom.* (1869), 2; *Sphaerella* (*Laestadia*) *Buxi* Fuckel, Cooke in *Journ. Bot.* (1883), 68; *Laestadia Buxi* (Fuckel) Sacc., *Syll. Fung.* II (1883), xxxi; *Trochila Buxi* Capron, in Cooke, *Handbook* (1871), 768.

Perithecia hypophyllous, immersed, each in a small, rose-coloured, depressed spot, which may become brown when old, 0·36 mm. diameter, depressed globose; wall of perithecium yellow; epidermis turning brown over the apex of the perithecium; asci oblongo-clavate, 66 × 11 μ, spores biseriate; ascospores narrow-oval or fusoid, ends rounded, sometimes inequilateral, sometimes with the lower end subtruncate, hyaline, continuous, 14–18 × 4–5 μ.

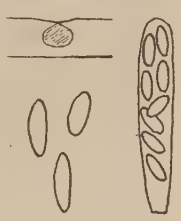

Fig. 1. *Hyponectria Buxi*; perithecium in leaf, × 40; ascus, × 400; ascospores, × 500.

On leaves of Box. Milton, Northants (Berkeley); Forden (Vize), in Plowright, *Sphaer. Brit.* no. 8, and Cooke, *Fung. Brit. Exsicc.* II, no. 478; Sandsend, Yorks, Hb. B.M.; Overstrand Woods, Norfolk, October 1934; Helmsley, Yorks, August 1935.

BATTARRINA Sacc., *Syll. Fung.* II (1883), 533 (as subgenus)

Perithecia immersed in the hymenium of the host (*Tuber puberulum*), globose, hyaline, sometimes confluent; asci cylindrical, eight-spored; ascospores hyaline, continuous, globose.

Battarrina inclusa (B. & Br.) Sacc., *Syll. Fung.* II. (1883), 533; *Hypocrea inclusa* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, VII (1861), 451, pl. 17, fig. 23.

Perithecia globose, about 0·25 mm. diameter, hyaline, sometimes confluent, astomate; wall thin, of parallel hyphae up to 4 μ diameter; asci at first broadly clavate, 16–20 × 5–6 μ, eight-spored, spores biseriate, becoming cylindric, 30 × 5 μ, soon diffluent, spores uniseriate, persisting in lines; ascospores globose, hyaline, 4–5 μ diameter, ornamented with an interrupted network of narrow bands which form a narrow border to the spore.

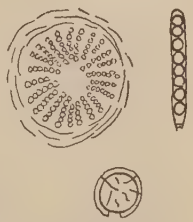

Fig. 2. *Battarrina inclusa*; cross-section of perithecium, × 100; ascus, × 1000; ascospore, × 1500.

Leigh Wood, Bristol, September–October 1859 (Broome), Hb. Kew. and Hb. B.M.; Hanham near Bristol, November 1869, November 1871 (Broome), Hb. Kew. and Hb. B.M., Rabh. *Fung. Europ.* no. 1610.

BYSSONECTRIA Karst. in *Medd. Soc. Fauna Fl. Fenn.* VI (1881), 6

Perithecia separate, superficial, on a common byssoid subiculum, bright-coloured, soft; asci eight-spored; ascospores hyaline, continuous, not filiform.

Byssonectria viridis (A. & S.) Petch in *Journ. Bot.* LXXV (1937), 220; *Sphaeria viridis* A. & S., *Consp. Fung.* (1805), 8, pl. 6, fig. 8; *Sphaeria luteovirens* b. Fries, *Syst. Mycol.* II (1822), 339; *Hypomyces viridis* (A. & S.) B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, XV (1865), 451; *Hypomyces luteovirens* Plowr. in *Grevillea*, XI (1882), 46; *Peckiella viridis* (A. & S.) Sacc., *Syll. Fung.* IX (1891), 944; *Hypomyces ater* Cooke in *Grevillea*, XII (1884), 80; *Peckiella atra* (Fr.) Sacc., *Syll. Fung.* IX (1891), 944.

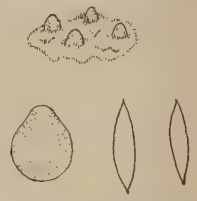

Fig. 3. *Byssonectria lateritia*; group of perithecia, × 15; perithecium, × 50; ascospores, × 750.

Subiculum thin, at first bright egg-yellow, becoming greenish and then almost black; perithecia crowded, ovoid, pallid, becoming brown or nearly black, 0·38 mm. high, 0·3 mm. diameter; asci cylindrical, 160 × 7–8 μ; ascospores narrow-oval or fusoid, sometimes inequilateral, ends produced into rather long, solid tips, which are often curved or hook-shaped, continuous, minutely warted, 27–45 × 5–6 μ.

Conidia oval, hyaline (Plowright).

On various agarics, especially *Lactarii*. Northamptonshire, July 1848, Hb. Kew. and Hb. B.M. South Wootton, 1878–9–80 (Plowright), Hb. B.M., Rehm, *Ascomyceten*, no. 586; Carlisle (Cooke), Hb. Kew.; Forres, September 1896 (Keith), Hb. Kew.

Byssonectria lateritia (Fr.) Petch in *Journ. Bot.* LXXV (1937), 220; *Sphaeria lateritia* Fr., Kunze, *Myc. Hefte*, II (1823), 42; *Hypocrea lateritia* Fr., *Summa Veg. Scand.* (1849), 383; *Hypomyces lateritius* Tul. in *Ann. Sci. Nat.* ser 4, XIII (1860), 11; *Peckiella lateritia* (Fr.) Maire in *Ann. Mycol.* IV (1906), 331.

Subiculum white, becoming pale yellow or yellowish brown; hyphae stout, with inflated segments, 15–18 × 7–9 μ, the terminal segment conoid, or broadly flask-shaped, or ovate, 15–20 × 9–10 μ, moderately thick-walled, pale brown; perithecia semi-immersed, ovato-globose, 0·3 mm. high, 0·25 mm. diameter, apex papillate, yellowish or brownish, darker than the subiculum, wall hyaline, becoming brown; asci cylindrical, with a long pedicel, 125–160 × 5–9 μ, spores uniseriate or obliquely uniseriate; ascospores lanceolate or narrow-oval, sometimes inequilateral, apiculate, sometimes acuminate, minutely verrucose, continuous, hyaline, 15–25 × 4–5 μ.

Conidia globose, hyaline, 3·5–7 μ diameter, on subulate conidiophores, 30–40 μ long (Tulasne).

On *Lactarii*, especially *L. deliciosus*. Leigh Wood, September 1844 (Broome), Hb. Kew. and Hb. B.M.; Leigh Wood, October, November, 1860 (Broome), Hb. Kew. and Hb. B.M., Rabh. *Fung. Europ.* no. 317; Hereford, 1871–74, Hb. Kew. and Hb. B.M., Plowright, *Sphaer. Brit.* I, no. 5; King's Lynn, October 1882 (Plowright), Hb. Kew., de Thümen, *Mycoth. Univ.* no. 2164; etc.

The specimens attributed to *Hypomyces torminosus* (Mont.) Tul., on *Lactarius*

torminosus, Dinmore, October 1874, Plowright, *Sphaer. Brit.* II, no. 4, Cooke, *Fung. Brit. Exsicc.* II, no. 667, Vize, *Microf.* no. 587, are *Hypomyces lateritius*, as are also "*Hypomyces torminosus*", North Wootton, October 1896 (Plowright), Hb. Kew., and King's Lynn, October 1900 (Plowright), Hb. B.M.

PSEUDONECTRIA Seaver in *Mycologia*, I (1909), 48

Perithecia separate, superficial, without a common subiculum, bright-coloured, soft; asci eight-spored; ascospores hyaline, continuous, not filiform.

Pseudonectria Rousseliana (Mont.) Seaver in *Mycologia*, I (1909), 48; *Nectria Rousseliana* Mont., *Syll. Crypt.* (1856), 224; *Nectriella Rousseliana* (Mont.) Sacc. in *Michelia*, I (1877), 51.

Perithecia superficial, gregarious, subglobose or conoid, 0·14–0·3 mm. diameter, 0·16–0·3 mm. high, straw-coloured, or brick-red, or greenish hyaline, sparsely clothed with hyaline, rigid, spreading setae; setae up to 100 μ long, 5 μ diameter, continuous or sparingly septate, apex obtuse or subacute; asci clavate, attenuated below, 54–60 × 6–8 μ, apex truncate, spores obliquely uniseriate, then biseriate; ascospores oval or somewhat lozenge-shaped, hyaline, continuous, thick-walled, 9–16 × 3–5 μ.

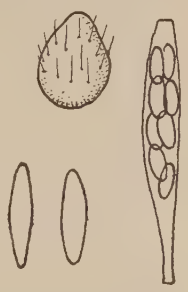

Fig. 4. *Pseudonectria Rousseliana*; perithecium, × 50; ascus, × 650; ascospores, × 1000.

On leaves of Box. Milton, Northants (Berkeley), Hb. Kew. Twycross, November 1856 (Bloxam), Hb. B.M. and Hb. Kew.; Batheaston, February 1859 (Broome), Hb. B.M. and Hb. Kew.; Elmhurst, March 1859, Hb. B.M.; Spye Park (Broome), Hb. Kew.; Dorking, Cooke, *Fung. Brit. Exsicc.* no. 597; Scarborough (Massee), Hb. B.M.; Kilnwick Percy, Yorks, August 1936.

Pseudonectria furfurella (B. & Br.) Petch, comb. nov.; *Nectria furfurella* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 4, VII (1871), 435; *Nectriella furfurella* (B. & Br.) Sacc. in *Michelia*, I (1878), 278.

"Perithecia on an effused fleshy stroma, flesh-coloured, subglobose, collapsing, beset with glistening scale-like particles. Paraphyses branched; sporidia ovate, 3·75–5 μ long; conidia 5–7·5 μ long. On cabbage stalks, Batheaston, February 1869."

The foregoing description is quoted from Berkeley and Broome (*loc. cit.*). There do not appear to be any perithecia on the type specimen in Hb. B.M. now. Saccardo (*loc. cit.*) suggested that *N. furfurella* was the same as *N. Keithii*, and Cooke adopted the suggestion in *Grevillea*, XII (1884), 10, but it is doubtful whether either had examined specimens. *Nectria furfurella* has not been reported again.

MELANOSPORA Corda, *Icon. Fung.* I (1837), 24

Perithecia separate, superficial, more or less globose, with a long beak fringed with hyaline setae at the tip, or without a beak, but with a fringe of setae round the ostiolum; asci usually eight-spored, soon

diffluent; ascospores continuous, fuscous, dark brown or black. Wall of perithecium membranous, hyaline or light-coloured, subtransparent, the whole appearing black when the ascospores are mature.

Fig. 5. *Melanospora cirrhata*; perithecium, × 60; ascospores, × 300.

Melanospora caprina (Fr.) Sacc., *Syll. Fung.* II (1883), 462; *Sphaeria caprina* Fr. in *Fl. Danica*, pl. 1859, fig. 2 (1829); *Ceratostoma caprinum* Fr., *Summa Veg. Scand.* (1849), 396; *Melanospora vervecina* (Desm.) Fuckel, *Symb. Mycol.* (1869), 126; *Sphaeria vervecina* Desm. in *Ann. Sci. Nat.* ser. 2, XVII (1842), 103.

Perithecia gregarious, on a rather compact, stout, tomentose, persistent, dark brown or purple-brown subiculum, depressed globose, clothed with a thick, white, woolly layer of tomentum, up to 0·8 mm. diameter (including the tomentum), with a beak, up to 1·8 mm. high, 0·2 mm. diameter below, tapering upwards and terminating in a pencil of hyaline setae; wall of the perithecium yellow, thick, parenchymatous, the exterior cells up to 30 μ diameter; wall of the beak yellow, of irregular, vertically elongated cells; hyphae of the tomentum thick-walled or almost solid, about 3 μ diameter, variously curled and intertwined, extending from the lower part of the perithecium over the subiculum; asci broadly clavate, 100 × 20 μ, spores clustered, or more or less biseriate; ascospores dark brown, broadly oval, or somewhat lemon-shaped, 16–23 × 9–16 μ.

On dead wood. Glamis, January 1874 (Stevenson), Hb. Kew.; no locality, December 1873 (Keith), Hb. Kew.; Clunyhill, November 1878 (Keith); Forres, on larch, Hb. Kew.; Carlisle, 16 December 1883 (Dr Carlyle), Hb. Kew.; Rudloe, November 1842 (Broome), Hb. Kew. Also recorded from Leigh Woods, Bristol, by Bucknall.

Melanospora chionea (Fr.) Corda, *Icon. Fung.* I (1837), 25, pl. 7, fig. 297; *Sphaeria chionea* Fr., *Syst. Mycol.* II (1823), 446; *Ceratostoma chionea* Fr., *Observ.* II (1818), 340, pl. 7, fig. 2.

Perithecia gregarious, globose or depressed globose, 0·36–0·5 mm. diameter, with a conical beak, 0·36–0·42 mm. high, 0·08–0·1 mm. diameter below, tapering to 0·04 mm. diameter above and terminating in a pencil of hyaline setae; beak and wall of the perithecium yellow or pale brown; beak composed of irregular, vertically elongated cells; wall of the perithecium parenchymatous, woolly with a dense white covering of hyaline, more or less regular, thick-walled hyphae, 2–2·5 μ diameter, variously curled and intertwined, in general not extending over the substratum; asci clavate with a long pedicel, sporiferous part, 35–45 × 14–18 μ (Winter), 56 × 16 μ (Fuckel), spores clustered, or more or less biseriate; ascospores oval or subcircular, discoid, dark brown, not apiculate, 10–16 × 8–12 μ, 4–6 μ thick.

On pine needles. Grantown, November 1878 (Keith), det. Plowright; Orton Moss, April 1881 (Dr Carlyle), Hb. Kew.; Dunkeld, 23 April 1914 (C. Rea), Hb. Kew.; without locality, May 1914 (J. W. Ellis), Hb. Kew. Also recorded for Bulmer, Yorks, in *Fungus Flora Yorks.*

Melanospora Zamiae Corda, *Icon. Fung.* I (1837), 24, pl. 7, fig. 297 A; *Ampullaria aurea* A. L. Smith in *Journ. Bot.* XLI (1903), 258.

Perithecia superficial, gregarious, globose, 160–400 μ diameter, with a long, cylindrical beak, terminated by a pencil of setae, 170–560 μ high, yellow or reddish, sparsely clothed with white or yellowish flexuose hyphae, wall yellow by transmitted light, or brownish yellow in old specimens; asci broadly clavate, 60–70 × 28–35 μ; ascospores lemon-shaped, dark brown to black, 18–23 × 12–16 μ.

On rotting plants under damp conditions. On dead clover seeds, Norwood, April 1903 (A. L. Smith); on seedlings from seed of Timothy grass infected with *Acremoniella atra*, Aberystwith, March 1927 (K. Sampson); on seedlings of Timothy grass, Kew (E. W. Mason); on bananas from the North Riding Laboratory of Pathology and Public Health, October 1931 (E. W. Mason). See Mason, in *Annotated Account of Fungi received at the Imperial Mycological Institute*, List II, fasc. 2 (1933).

Melanospora cirrhata Berk., *British Fungi*, No. 325 (1843); ? *Gibsonia phaeospora* Massee in *Ann. Bot.* XXIII (1909), 366.

Perithecia small, scattered, globose, 0·2 mm. diameter, with a cylindrical, straight or curved beak, 0·25 mm. high, 0·08 mm. diameter, abruptly defined from the perithecium and terminating in a pencil of hyaline setae; wall of the perithecium and beak yellow-brown (in herb. specimens), parenchymatous, membranous, the membrane of irregularly longitudinal cells; perithecium sparsely clothed with pale yellowish spreading hyphae, thick-walled or almost solid, 2·5 μ diameter, which also extend in a circular patch from the base of the perithecium over the substratum; asci not seen; ascospores dark brown, broadly oval, not or slightly apiculate, 13–18 × 10–13 μ, or circular, 15 μ diameter.

On straw, King's Cliffe, 16 April 1841 (Berkeley), Hb. Kew. and Hb. B.M.

Melanospora leucotricha Corda, *Icon. Fung.* I (1837), 25, pl. 7, fig. 297 C.

Perithecia gregarious or scattered, on a cobwebby mycelium which may overrun wide areas, globose, 0·3 mm. diameter, passing into a conoid or subcylindrical beak, 0·35 mm. high, of which the uppermost 0·1 mm. consists of a pencil of hyaline setae; perithecium "translucent yellowish white", yellow-brown in herbarium specimens, wall parenchymatous, stout, about 66 μ thick, covered with loosely intertwined, white, thick-walled hyphae, 2–3 μ diameter, which usually do not spread out radially to the substratum; beak 90 μ diameter below, 75 μ above, thick-walled, yellow-brown, externally glandular with thick-walled, irregularly oval or pyriform

cells, about 12 × 9 μ; asci "oblong, stalked, 4 or 8-spored, sporiferous part 38–50 μ long, 17–23 μ broad" (Winter); ascospores dark brown, broadly ellipsoid, apiculate, 17–23 × 13–18 μ.

"On heaps of rotting leaves, stems, branches, wood, even running over stones." No British specimens are available. The foregoing description has been drawn up from Rabh.-Winter, no. 2757, Leipzig 1881, on decaying leaves. Recorded on decaying Cherry Laurel leaves, Monaghan (*Trans. Brit. Mycol. Soc.* III, 210); also, on plates exposed over apple orchards, F. M. Carter (*op. cit.* XIX, 146).

Melanospora parasitica Tul., *Sel. Fung. Carp.* III (1865), 10, pl. 3, figs. 11–14.

Perithecia partly immersed in the hyphae of the host, globose, about 0·2 mm. diameter, with a long cylindrical beak, up to 2·5 mm. high, 50–90 μ diameter below, tapering to 20–40 μ above, terminated by a pencil of hyaline setae, at first entirely hyaline, becoming brownish to reddish brown; wall of the perithecium parenchymatous, membranous; wall of the beak composed of somewhat irregular, but more or less parallel hyphae; with stout hyphae arising from the perithecial wall and spreading through the host, and a slight covering of contorted hyphae at the base of the beak; asci clavate, eight-spored, 27 × 5 μ, soon disappearing; ascospores cylindrical, ends truncate, fuscous to black, 5–8 × 2–2·5 μ.

On entomogenous fungi. On *Isaria farinosa*, West Briggs, near King's Lynn, 10 September 1931; Rawcliffe, Yorks, 4 August 1934. On *Beauveria Bassiana*, Dartington, Devon, 25 September 1935. Recorded by Plowright (*Grevillea*, X, 71) on *Isaria farinosa*, North Wootton, September 1880.

Melanospora lagenaria (Pers.) Fuckel, *Symb. Mycol.* (1869), 126; *Sphaeria lagenaria* Pers., *Synopsis* (1801), 58; *Ceratostoma lagenarium* (Pers.) Fr., *Observ.* II (1818), 341; *Melanospora lagenaria* var. *tetraspora* Rehm in *Hedwigia* (1891), 259.

Perithecia scattered or clustered, sometimes connate, globose, or conoid above and merging gradually into the beak, yellowish brown, becoming dark brown, 0·36–0·5 mm. diameter, with a beak up to 1·5 mm. high, 0·2 mm. diameter below, tapering to 0·1 mm. diameter above, straight or curved, terminating in a pencil of hyaline setae; wall of the perithecium stout, subopaque, hispid above with short yellowish hairs, clothed below with longer hyphae which sometimes envelop adjacent perithecia; beak glabrous, dark red-brown in old specimens; asci stalked, broadly clavate, sporiferous part 36 × 13 μ, eight-, four-, or three-spored in the same perithecium, spores clustered; ascospores dark brown, ellipsoid, sometimes inequilateral, slightly apiculate, 13–22 × 7–14 μ.

On old *Polypori*. On *Polyporus adustus*, Queen's Cottage, Kew, April 1888 (Cooke), Hb. Kew.; on *Polyporus*, Epping Forest, 19 October 1918 (Wakefield), Hb. Kew. Also recorded on decaying ? *Stereum*, Bushey Park (*Trans. Brit. Mycol. Soc.* II, 93), and on *Polystictus versicolor*, Eglinton, Ayrshire (*op. cit.* VI, 47).

Melanospora brevirostris (Fuckel) v. Höhnel in *Sitzb. k. Akad. d. Wiss. Wien*, CXXII (1914), 94; *Ceratostoma brevirostre* Fuckel in *Bot. Zeit.* XIX (1861), 250, pl. 10, fig. 4; *Melanospora Zobelii* Fuckel *non* Corda, *Symb. Mycol.* (1869), 127; *Ceratostoma Helvellae* Cooke in *Grevillea*, I (1873), 175; *Melanospora Helvellae* (Cooke) Sacc. in *Michelia*, I (1878), 283.

Perithecia at first ovoid and astomate, becoming subglobose with a conical apex which opens by a pore surrounded by hyaline setae, which sometimes develop into a cylindrical, hyaline beak, up to 180 μ high; perithecia superficial, scattered or crowded, up to 0·36 mm. diameter, wall parenchymatous, stout, brown, smooth, or with a few adherent brown hyphae; asci not seen; ascospores oval, sometimes acuminate, sometimes inequilateral, ends truncate, dark brown, 22–31 × 13–16 μ, with some globose, 13–16 μ diameter.

On the disc of *Sepultaria arenosa* and allied Discomycetes, sometimes entirely covering it. On *Peziza sepulta*, without locality, November 1858 (Rev. H. Higgins), Hb. Kew. ex Hb. Currey; on *Peziza hemisphaerica*, Eastbourne, February 1873 (C. J. Muller), Hb. Kew.; Sandhills, South Lancashire, June 1920 (W. G. Travis), Hb. B.M. Also recorded, as *M. Zobelii*, on *Sepultaria arenicola* (Lév.) Mass., Wallasey Sandhills, 25 November 1913 (J. W. Ellis), in *Trans. Brit. Mycol. Soc.* IV, 314.

Melanospora damnosa (Sacc.) Lindau in Engler-Prantl, *Naturl. Pflanzenf.*, Teil I, abt. 1, 353 (1897); *Sphaeroderma damnosum* Sacc., in Berlese, *Rivista Pat. Veget.* (1895), 9, pls. 7 and 8.

Perithecia concealed beneath the raised periderm, only the white pencil of convergent setae visible externally. Perithecia globose, about 250 μ diameter, ochraceous or reddish, with a short cylindrical beak about 50 μ high, crowned with a white conical pencil of hyaline setae, about 350 μ high; wall yellow or brownish yellow by transmitted light, clothed with hyaline or yellowish hyphae; asci broadly clavate, four-spored, about 45 × 18 μ; ascospores broadly ellipsoid or subglobose, not or slightly apiculate, dark brown, black in mass, 16–21 × 12–18 μ.

On elm twigs, Kew, kept in a damp chamber, July 1932 (E. W. Mason).

Melanospora fimbriata (Rostrup) Petch, comb. nov.; *Sphaeroderma fimbriatum* Rostrup, *Oest. Groenl. Svampe* (1894), 25.

Subiculum obsolete; perithecia very small, globose, reddish, ostiolum fimbriate; asci cylindraceo-clavate, 100–110 × 20 μ; ascospores ellipsoid, fuscous, 20 × 11–12 μ (Rostrup).

On dung of guinea-pig, Kew (Massee & Salmon). No specimens available.

Melanospora sphaerodermoides Grove in *Journ. Bot.* XXIII (1885), 132, pl. 256, fig. 4.

Perithecia superficial, scattered, almost smooth, pale yellow-brown, then brown, subglobose, conoid above, about 0·35 mm. diameter, 0·4 mm. high, opening by a pore surrounded by a short collar, with

hyaline setae at the upper edge of the collar; setae 50–60 μ long, rigid, acute, continuous, up to 5 μ diameter below, tapering to the tip; wall parenchymatous, rigid, of large hexagonal cells; asci obovate-clavate, stalked, eight-spored, 80–90 × 30 μ; ascospores oval or inequilaterally oval, or subcymbiform, ends truncate, with a germ pore, sometimes shortly acuminate, black, 27–34 × 13–16 μ.

On culms of *Heracleum*, Warwickshire (Grove); on decaying stalks of *Brassica*, North Wootton, November 1935.

Melanospora Zobelii (Corda) Fuckel, *Symb. Mycol.* (1869), 127; *Microthecium Zobelii* Corda, *Icon. Fung.* v (1842), 74, pl. 8, fig. 53; *Sphaeria* (*Hypocrea*) *Zobelii* (Cda.) Tul., *Fungi Hypogaei* (1851), 186, pl. 13, fig. 1; *Ceratostoma Zobelii* (Cda.) Berk., *Outlines* (1860), 402.

Perithecia membranous, immersed or partly immersed, at first globose and astomate, becoming globose with a conical apex and opening by an apical pore; setae not observed; ascospores almost black, lemon-shaped, ends truncate, 21 × 12 μ (Corda), 23 × 16 μ (Tulasne).

On or in the hymenium of truffles. Recorded for Britain by Berkeley (*loc. cit. supra*) without locality; not represented in British Herbaria. When specimens are available, this species may prove to be identical with *Melanospora brevirostris*, as was maintained by Fuckel.

SPHAERODERMA Fuckel, *Symb. Mycol.* App. III (1875), 22

Perithecia and ascospores as in *Melanospora*, but without a beak or setae round the ostiolum.

Sphaeroderma fusisporum Petch in *Naturalist*, (1936), 58.

Fig. 6. *Sphaeroderma fusisporum*; perithecium, ×33; ascospore, × 400.

Perithecia scattered, superficial, orange, globose, up to 0·3 mm. diameter, at first astomate, but developing a papillate ostiolum and subsequently a collar round the orifice, glabrous, or with a few adpressed hyphae; wall yellow by transmitted light, parenchymatous, of large cells; asci eight-spored, clavate, 66 × 12 μ, soon diffluent, spores obliquely uniseriate, or biseriate; ascospores lanceolate, fuliginous, apices obtuse, or truncate with a germ pore, continuous, with a large central gutta, 20–24 × 6–9 μ. Perithecia appearing black from the apex downwards as the spores mature.

On *Isaria farinosa*, Saltaire, Yorks, September 1935; North Wootton, Norfolk, October 1936.

Sphaeroderma episphaeria (Phil. & Plowr.) Sacc., *Syll. Fung.* II (1883), 560; *Melanospora episphaeria* Phil. & Plowr. in *Grevillea*, X (1881), 71, pl. 158, fig. 2; *Microthecium episphaerium* (Phil. & Plowr.) v. Höhnel in *Sitzb. k. Akad. d. Wiss. Wien*, CXXIII (1914), Abt. 1, 98;

Sphaerodes episphaerium (Phil. & Plowr.) Clements, *Genera of Fungi* (1909), 44 and 173; *Vittadinula episphaeria* (Phil. & Plowr.) Sacc., in Shear and Clements, *Genera of Fungi* (1931); *Sphaeroderma epimyces* v. Höhnel, *Fragmente zur Mykologie*, no. 105 (1907).

Perithecia superficial, globose, 0·25–0·35 mm. diameter, becoming globose with a papillate apex and opening by an apical pore, at first hyaline, then appearing black; wall in dried specimens brownish yellow; asci cylindrical, then pyriform, soon disappearing; spore-cluster ovate, about 66 × 22 μ; ascospores lemon-shaped, ends truncate, at first hyaline with vacuolate contents, then almost black and reticulated with a wide-meshed network of narrow lines, 25–34 × 12–18 μ.

On *Hypomyces ochraceus* (Pers.) Tul. North Wootton and Holt House Wood, near King's Lynn, October 1880 (Plowright), Hb. Kew.; Ashwicken, 28 October 1896 (Plowright).

Sphaeroderma Hulseboschii Oud., *Contr. Flor. Pays Bas* XI (1886), 23.

Perithecia superficial, without any subiculum, subglobose, 0·7 mm. diameter, pale ochraceous, ostiolum short, obtusely conical; asci pyriform, 50 × 25 μ, eight-spored; ascospores lemon-shaped, sub-olivaceous, 19–21 × 11–12 μ (Oudemans).

On rabbit dung, Leith Hill, Surrey (Massee & Salmon). No specimens available. Probably not different from *Sphaeroderma fimicolum* (E. C. Hans.) Sacc.

NECTRIA Fries, *Summa Veg. Scand.* (1849), 387 (in part)

Perithecia superficial, separate, but caespitose on a superficial or erumpent, parenchymatous, bright-coloured stroma, bright-coloured, soft; asci usually eight-spored, sometimes polysporous by budding from the ascospores; ascospores hyaline, one-septate. In some species, scattered perithecia may occur in company with the normal stromatic clusters.

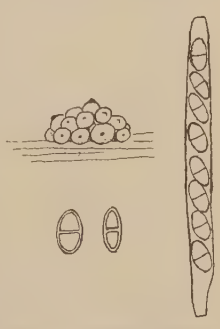

Fig. 7. *Nectria coccinea*: group of perithecia, × 10; ascus, × 500; ascospores, × 500.

Nectria cinnabarina (Tode) Fr., *Summa Veg. Scand.* (1849), 388; *Sphaeria ochracea* Grev. & Fr., *Elenchus*, II (1828), 79; *Nectria ochracea* (Grev. & Fr.) Fr., *Summa Veg. Scand.* (1849), 387; *Nectria fuscopurpurea* Wakefield in *Kew Bulletin* (1918), 232.

Perithecia crowded on an erumpent pulvinate stroma, cinnabar or purple-red, darkening with age, globose, up to 0·4 mm. diameter, covered with coarse warts, ostiolum naked, papillate; asci cylindrico-clavate, eight-spored, spores biseriate; ascospores oblong or narrow-oval, often inequilateral, ends rounded, one-septate, 12–25 × 4–9 μ; paraphyses stout, septate, branched.

Conidial stage, *Tubercularia vulgaris* Tode, pulvinate, red, subtranslucent when moist, pink when dry; conidia oblong-oval or subcylindric, ends rounded, straight or slightly curved, 6–9 × 2–2·5 μ.

Common on dead branches.

In the type of *Nectria fuscopurpurea*, the perithecia are almost smooth, turbinate and concave or strongly umbilicate when dry, and some of the ascospores are up to 33 μ long, and two to three septate. The majority of the ascospores, however, are those of *N. cinnabarina*, and it would appear to be an abnormality of that species. There is a similar specimen in Hb. Kew., ex Hb. Berkeley, without date or locality, labelled "*Sphaeria cucurbitula* Tode, 47", by Berkeley and I have recent specimens from Norfolk and Yorkshire.

Nectria Ralfsii B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, XIII (1854), 467.

Perithecia in small groups of about six on a small superficial stroma which is yellow internally, depressed globose, 0·33 mm. diameter, orange, covered with large, confluent, paler warts composed of more or less globose, thick-walled cells, 9–12 μ diameter, naked round the minute, conical ostiolum; asci clavate, 70 × 14–16 μ, spores biseriate; ascospores oval, narrow-oval, oblong-oval, or fusoid, hyaline, one-septate, the lower cell often narrower and tapering, 16–27 × 6–9 μ, with some, one-septate, broadly ellipsoid, 12–14 × 9 μ, and some globose, one-celled, 9–12 μ diameter.

On ? beech, Penzance (Ralfs), Hb. Kew. and Hb. B.M.; on gorse, Penzance (Ralfs), Hb. Kew. and Hb. B.M.; Southampton, February 1910 (Rayner), Hb. B.M.; on *Acer*, Berry Pomeroy, Devon, September 1935 (E. M. Wakefield) Hb. Kew. Also recorded from Goole (*Naturalist*, September 1881).

Nectria subquaternata B. & Br. in *Journ. Linn. Soc.* XIV (1873), 116; *Nectria squamuligera* Sacc., *Fungi Veneti*, ser. 4, 22 (1875); *Nectria Keithii* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 4, XVII (1876), 144; *Nectriella Keithii* (B. & Br.) Sacc. in *Michelia*, I (1878), 278.

Perithecia clustered on a thin, fleshy, yellow or yellow-brown stroma, or scattered, globose, 0·25 mm. diameter, pale yellow-brown to dark brown, subtranslucent when moist, at first with a conspicuous ring of white parenchymatous warts round the ostiolum, the warts subsequently becoming scattered and of the same colour as the perithecium; ostiolum minute, conical, naked; wall stout, of small cells, yellow-brown; asci subcylindric or clavate, almost sessile, apex truncate, 48–60 × 7–10 μ; paraphyses filiform, branched; ascospores narrow-oval or subcylindrical, sometimes inequilateral, one-septate, ends obtuse, 9–16 × 3–5 μ.

On decaying stalks of *Brassica*. Batheaston, 5 March 1877 (Broome), Hb. B.M.; Forres, (Keith), Hb. Kew.; North Wootton, King's Lynn, October 1935.

The specimens on stalks of *Brassica* differ in colour from Ceylon and Italian specimens, the latter being pale flesh-coloured when fresh, and yellow or pallid when dry. A specimen in Hb. B.M., labelled "*N. squamuligera*, Mulgrave Woods, July 1910, T. Gibbs", is *Nectria Peziza* (Tode) Fr.

Nectria inventa Pethybridge in *Trans. Brit. Mycol. Soc.* VI (1920), 107.

Perithecia gregarious, on a small, dark brown, superficial stroma, which is sometimes situated in a decaying patch of *Acrostalagmus cinnabarinus*, globose, 300–500 μ diameter, blackish brown, bearing short, rigid, septate hairs on the upper half; hairs hyaline, up to 175 μ high, 6 μ diameter below, tapering upwards, septate, regular, or sometimes with an oval swelling at varying heights, apex acute, sometimes lanceolate; wall of the perithecium of small cells, yellow-brown by transmitted light; asci cylindrical or cylindrico-clavate, 60–100 × 4–6 μ, eight-spored; paraphyses filiform, 150 × 3–4 μ, diffluent; ascospores obliquely uniseriate, oblong, ends rounded, hyaline, one-septate, 8–12 × 3–5 μ.

Conidial stage, *Acrostalagmus cinnabarinus* Corda.

On rotting potatoes, Ireland (Pethybridge). On decaying stalks of *Brassica*, North Wootton, King's Lynn, November 1935, October 1936.

Nectria coccinea (Pers.) Fr., *Summa Veg. Scand.* (1849), 388.

Perithecia usually clustered on a red stroma, which is yellow internally, sometimes scattered without a stroma, globose, 0·25–0·3 mm. diameter, with an evident conical ostiolum, yellowish red, ostiolum darker, becoming dark red, smooth; perithecial wall of rather large cells; asci cylindrical or narrow-clavate, apex truncate and thickened, with a central pore, spores uniseriate, or obliquely uniseriate, or biseriate above, the uppermost spore sometimes some distance below the apex, asci sometimes clavate with a rounded apex and the uppermost spore in contact, but the original thickened apex persisting as a small disc, 66–95 × 8–12 μ; paraphyses surrounding the mass of asci, broad, septate, and branched as in *Dialonectria galligena*, but thin-walled and soon diffluent; ascospores narrow-oval, oblong-oval, or sub-fusoid, ends rounded, one-septate, sometimes slightly constricted, hyaline, minutely warted, 12–19 × 5–7 μ.

On dead branches; common.

Nectria punicea (K. & Schm.) Fr., *Summa Veg. Scand.* (1849), 387; *Nectria ditissima* Tul., *Sel. Fung. Carp.* III (1865), 72.

Perithecia caespitose on a red stroma which is subgelatinous when moist, globose or globoso-conoid, sometimes distinctly conoid when effete, up to 0·36 mm. high, 0·3 mm. diameter, with a minute, papillate, scarcely elevated ostiolum, bright red, becoming purple-red, dark red and subtranslucent when moist, pruinose, becoming dull brownish red and smooth, sometimes brownish yellow in old specimens; asci at first subfusoid, then clavate, apex at first obtuse or subtruncate, not thickened, finally rounded, 90–100 × 10–12 μ, spores obliquely uniseriate, becoming biseriate above; paraphyses broad,

septate and branched as in *Dialonectria galligena*, but thin-walled and soon diffluent; ascospores narrow-oval, or oblong-oval, sometimes inequilateral, one-septate, hyaline, minutely warted, 12–20 × 4–7 μ.

Conidial stage; the conidial fungus which occurs commonly with this species is *Tubercularia minor* Link, Sp. Plant., VI, 2 (1825), 100, *T. crassostipitata* Fuckel, *Symb. Mycol.* (1869), 180, but there is some doubt whether it is the conidial stage of *N. punicea*.

On *Rhamnus frangula*; Highgate, Cooke, *Fung. Brit. Exsicc.* no. 370, and ed. II, no. 475; Bishop's Wood, February 1866 (Cooke), Hb. Kew. On laburnum, Leicester (F. T. Mott) and Kingscliffe (Berkeley), Hb. Kew., det. Ehrlich. On ash, Forden, Vize, *Microf. Brit.* no. 152, det. Ehrlich. On holly, Forden, Vize, *Microf. Brit.* no. 373, and Shere (Cooke), Hb. Kew, det. Ehrlich., etc. On beech, North Wootton, March 1937. On broom, North Wootton, November 1933; Norwich, October 1934. On ivy, Wheatfen Broad, Norfolk, January 1936 (E. A. Ellis).

Nectria sinopica Fr., *Summa Veg. Scand.* (1849), 388.

Perithecia crowded on a pale red erumpent stroma (yellow internally), globose, 0·25–0·3 mm. diameter, with a small conical ostiolum, becoming umbilicate when old, at first light red or brick-red, subtranslucent, pruinose with yellow granules, ostiolum darker, becoming dark red, and finally purple-red or blackish; asci cylindrical, 60–90 × 6–9 μ; ascospores ellipsoid or oblong-oval, sometimes inequilateral, 9–15 × 4–6 μ, hyaline, becoming pale yellow.

Pycnidial stage, *Zythiostroma Mougeotii* (Fr.) v. Höhn., pycnidia subcortical, ostiolum erumpent, or exposed by abscission of the cortex, scattered, red, soft, subtranslucent, subglobose or conoid, 0·25–0·4 mm. diameter, ostiolum cylindrical, dark red; pycnospores oblong-oval, 2·5–3·5 × 1 μ. With the perithecial stage.

On dead stems of ivy; generally distributed.

Nectria cucurbitula Sacc. in *Michelia*, I (1878), 409; *Sphaeria cucurbitula* var. β. *nigrescens* Tode, *Fung. Meckl.* II (1791), 39; *Nectria cucurbitula* (Tode) Fr. (in part), *Summa Veg. Scand.* (1849), 388.

Perithecia caespitose on an immersed or feebly erumpent stroma, at first brick-red, then blood-red, later becoming purple brown and finally blackish, globose, with a small conical ostiolum, smooth, generally shining, about 0·3 mm. diameter; asci cylindrical or slightly clavate, subsessile, 90–110 × 7–9 μ, apex truncate and thickened, spores uniseriate or obliquely uniseriate; ascospores oval or oblong-oval, ends rounded or sometimes somewhat triangular, hyaline, one-septate, not or slightly constricted, 12–15 × 5–6 μ.

On coniferous logs. On *Picea excelsa*, near Braco, Perthshire, 31 March 1935; on *Pinus sylvestris* and ? *Larix europaea*, Benmore Forestry Reserve, Argyllshire, 30 March 1935 (C. G. C. Chesters), det. Ehrlich.

This species has been confused with *Nectria Coryli*, and most of the British records refer to the latter.

[***Nectria Solani*** Reinke & Berth., *Zersetz. d. Kartoffel* (1879), 39.

Perithecia crowded on an erumpent convoluted stroma, globoso-conoid, with a conical ostiolum, pale ochraceous, almost white, or orange-red; asci cylindrico-clavate or broadly clavate, 45–65 × 7–11 μ; ascospores oblong or oblong-oval, ends acute, hyaline, one-septate, constricted at the septum, 8–14 × 4–6 μ.

Conidial stage. Reinke and Berthold state that the conidial stage of *Nectria Solani* is *Spicaria Solani* de Bary. Their figure shows a *Gliocladium*, with narrow-oval or lanceolate conidia, 4–5 × 3 μ.

Pethybridge (*Trans. Brit. Mycol. Soc.* VI (1920), 105) states that there is no reliable record of the occurrence of *Nectria Solani* in the British Isles.]

Nectria Coryli Fuckel, *Symb. Mycol.* (1869), 180; *Nectria cucurbitula* Currey in *Trans. Linn. Soc.* XXII (1858), 282, pl. 49, fig. 178; *Chilonectria cucurbitula* (Curr.) Sacc. (in part) in *Michelia*, I (1878), 280.

Perithecia erumpent, caespitose, orange, yellowish red, or red, sometimes covered with yellow particles, becoming dark red, blackening when old, globose, 0·3 mm. diameter, with a minute conical ostiolum, darker than the rest of the perithecium, becoming cup-shaped or turbinate when dry; asci narrow-clavate, apex truncate and thickened, 75–95 × 5–7 μ, spores uniseriate or obliquely uniseriate, or partly biseriate; paraphyses linear, diffluent; ascospores narrow-oval or subcymbiform, hyaline, one-septate, not or slightly constricted, 10–18 × 4–5 μ, budding in the ascus and producing myriads of minute, curved, allantoid hyaline sporidia, 2–4 × 0·75–1 μ; the perithecia may also contain subcylindric, three-septate, hyaline spores, 40–42 × 5–7 μ.

On ash (Berkeley), Hb. Kew. On privet, Lucknam, March 1850 (Broome), Hb. B.M. On hazel, Batheaston, February 1859 (Broome), Hb. B.M.; Rokeby, September 1933. On alder, Booton Common, Norfolk, March 1936 (E. A. Ellis). Also recorded on *Ulex*, Leziate Fen, King's Lynn (B.M.S.).

Nectria Aquifolii (Fr.) Berk., *Outlines*, etc. (1860), 393; *Sphaeria Aquifolii* Fries, *Elenchus*, II (1828), 82; *Nectria inaurata* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, XIII (1854), 467; *Aponectria inaurata* (B. & Br.) Sacc. in *Michelia*, I (1878), 296.

Perithecia erumpent, caespitose on an immersed or erumpent stroma which is yellow or brownish internally, pale red becoming dark red, sometimes naked, sometimes strongly encrusted with yellow or greenish yellow granules, blackening when old, globose, 0·25–0·4 mm. diameter, with a dark brown or almost black papilla, sometimes becoming flat-topped, broadly umbilicate and subturbinate when dry; asci cylindrical or clavate, 60–85 × 7–11 μ, eight-spored, or containing numerous sporidia; ascospores oval, one-septate, 9–15 × 4–7 μ; sporidia cylindric or narrow-oval, straight or curved, 4–6 × 1–1·5 μ.

On dead branches and stems of holly; generally distributed, but often recorded in error for *N. punicea* and *N. coccinea*, both of which occur on holly.

Nectria mammoidea Phil. & Plowr. in *Grevillea*, III (1875), 126.

Perithecia caespitose, frequently scattered, red or yellowish red, with a dark red (appearing black) apical area, becoming entirely dark red or purple-brown when old, sometimes pruinose or furfuraceous, globose, up to 0·5 mm. diameter, smooth, not collapsing, ostiolum minute, conical; wall rigid, tough, with a parchment-like layer which often persists after the decay of the rest of the perithecium; asci cylindrical or narrow-clavate, almost sessile, 90–130 × 10–14 μ, spores uniseriate or obliquely uniseriate; paraphyses linear; ascospores narrow-oval or subcymbiform, sometimes broadly fusoid, ends rounded, one-septate, hyaline becoming pale yellow, very minutely warted, 14–25 × 6–9 μ.

Var. *Rubi* Weese in *Zeitschr. Garungsphys.* I (1912), 128; *Nectria Rubi* Osterw. in *Ber. deutsch. Bot. Gesell.* XXIX (1911), 620, tab. xxii.

Perithecia as in the type, but spores smaller, 15·9–18·6 × 4·6–5·2 μ (Osterwalder).

On gorse; also on elm, etc. North Wootton, November 1873, 1874, Plowright, *Sphaer. Brit.* II, 5; Ercall, January 1874 (Phillips), Hb. B.M.; Scarborough (Massee) Hb. B.M.; Mulgrave, May 1911, Hb. B.M.; Rokeby, September 1933; Matlock Bath, June 1935; Dartington, September 1935. Also recorded from Walton Hill and Leigh Wood, July 1881 (Bucknall); Tintern (B.M.S.); Leziate (B.M.S.).

Var. *Rubi*. On roots of bramble, Batheaston, April 1870 (Broome), Hb. B.M.; North Wootton, February 1937. On raspberry, recorded for Scotland by Alcock (*Trans. Bot. Soc. Edinb.* XXIX (1925), 197), for Ireland by Pethybridge (*Trans. Brit. Mycol. Soc.* XII (1927), 20), and for Worcestershire by Nattrass (*tom. cit.*, p. 23).

Nectria Magnusiana Rehm, *Ascomyceten*, no. 436.

Perithecia caespitose on an inconspicuous stroma, globose, 0·25 mm. diameter, slightly papillate when young, collapsing and becoming regularly cup-shaped, bright red, becoming dull red and then blackening, minutely rugose; asci cylindrical, almost sessile, apex rounded and thickened, 75–90 × 7–8 μ, spores uniseriate or obliquely uniseriate; ascospores ellipsoid, ends rounded, smooth, one-septate, hyaline becoming reddish, 9–14 × 5–7 μ.

Conidial stage, *Dendrodochium epistroma* v. Höhn., *Fragm. z. Mykol.* VI, no. 284. Sporodochia minute, pulvinate, or confluent in patches, pale red when fresh, orange-red or blood-red when dry, rather soft; conidiophores branched above, conidia terminal; conidia hyaline, cylindrical, straight or curved, 3–7 × 0·75–1 μ.

On *Diatrypella* on birch, with the conidial stage, Logan Woods, near Sandhead, Wigtownshire, August 1936 (C. G. C. Chesters); Becca Park, Aberford, Yorks. October 1937 (W. G. Bramley); conidial stage only, Great Bear Park, Warwickshire (Grove); North Wootton, near King's Lynn, November 1935, February 1936, etc.

Nectria ochroleuca (Schw.) Berk. in *Grevillea*, IV (1875), 16; *Sphaeria ochroleuca* Schw. in *Trans. Amer. Phil. Soc.* n.s. IV (1832), 204.

Perithecia caespitose, on a small, inconspicuous, erumpent, pulvinate stroma, which is sometimes floccose with white conidiophores, globose, small, about 0·2 mm. diameter, minutely rugose, pale yellow or almost white, opaque, dark round the minute, conical ostiolum; asci sessile, narrow-clavate or subcylindrical, apex truncate and impressed, spores uniseriate, or sometimes biseriate above, 55–66 × 5–6 μ; paraphyses not seen; ascospores narrow-oval, often inequilateral, or fusoid, straight or slightly curved, 10–14 × 3–4 μ, sometimes 15–18 × 3·5 μ and two- or three-septate.

Conidiophore verticillate (*Verticillium tubercularioides* Speg.); conidia elliptical, hyaline, 5–8 × 3 μ (Seaver).

Coed Coch, October 1880 (Cooke); on wych elm, Forden, Vize no. 2, Hb. Cooke; Baslow, September 1919 (E. M. Wakefield); all in Hb. Kew., det. or confirmed Ehrlich.

Nectria pallidula Cooke in *Grevillea*, XVII (1888), 3.

Perithecia scattered or crowded, on an erumpent, pulvinate, subgelatinous stroma which shrinks and blackens on drying, small, subglobose with a minute, conical ostiolum, or ovoid, 0·18–0·25 mm. diameter, sordid ochraceous, subtranslucent when fresh, becoming dull ochraceous, or pale yellow and opaque when dry, faintly rugose, ostiolum situated on a darker, subtranslucent area on the yellow, opaque examples; stroma yellowish internally, fibroso-gelatinous, base of the perithecium sometimes embedded in the stroma; cells of the perithecial wall filled with a yellow oil when fresh; asci almost sessile, clavate, 50–60 × 7–9 μ, apex truncate and impressed; spores obliquely uniseriate, becoming biseriate above; paraphyses linear; ascospores narrow-oval, oblong-oval, or subfusoid, ends rounded, one-septate, hyaline, 9–14 × 3–4 μ.

On beech, Carlisle (Cooke), Hb. Kew.; on broom, North Wootton, 22 October 1934.

On the available specimens, *N. pallidula* differs from *N. ochroleuca* in its subgelatinous stroma, its shorter and broader asci, and in the presence of oil globules in the perithecial wall. Its perithecia vary from dull ochraceous and subtranslucent to pale yellow and opaque, the latter resembling exactly those of *N. ochroleuca*. It is possible that a wider range of specimens may prove them identical.

Nectria citrino-aurantia (de Lacr.) Desm., *Pl. Crypt. France* (1860), no. 778; *Calonectria citrino-aurantia* (de Lacr.) Sacc. in *Michelia*, I (1878), 314.

Perithecia small, crowded on an erumpent, pulvinate, pale yellow, subgelatinous stroma, often with the base immersed, oval or conoid, about 0·1 mm. diameter, 0·15 mm. high, pale yellow or ochraceous, subtranslucent, umbilicate when dry, smooth; asci clavate, 30–40 × 5 μ; ascospores cylindrical, subfusoid, or narrow-oval, hyaline, one-septate, 6–9 × 2–2·5 μ, with a few globose, continuous, 3 μ diameter.

On willow twigs, Batheaston, December 1873 (Broome), Hb. Kew. and Hb. B.M.

SPHAEROSTILBE Tulasne, *Sel. Fung. Carp.* I (1861), 130

Perithecia and ascospores as in *Nectria*, but usually accompanied by an erect *Stilbella* or *Microcera* conidial stage; if the conidial stage is absent, the perithecia appear as *Nectria* (in *S. aurantiaca*), or as *Hyphonectria* (in *S. flammea*).

Sphaerostilbe aurantiaca Tul., *Sel. Fung. Carp.* I (1861), 130, and III (1865), 101.

Perithecia arising from the base of the conidial form, or independently, caespitose, globose, up to 0·4 mm. diameter, slightly umbilicate, pruinose or minutely fibrillose, yellowish red becoming purple-red; asci broadly clavate, with a long, thin, or a short, stout pedicel, 90–130 × 18–22 μ; ascospores oval, one-septate, not or slightly constricted, 20–29 × 8–10 μ.

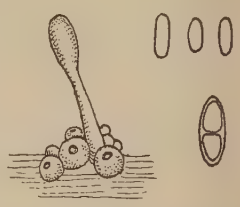

Fig. 8. *Sphaerostilbe aurantiaca*; perithecia and *Stilbella*, × 12; conidia, × 400; ascospore, × 400.

Conidial stage, *Stilbella aurantiaca* (Bab.) Lindau in *Rabh. Krypt-Flora* IX (1908), 298; *Stilbum aurantiacum* Babington, in Berkeley in *Ann. Mag. Nat. Hist.* VI (1841), 432, pl. 12, fig. 14. Solitary or fasciculate, up to 2 mm. high, rarely terete, usually compressed and laterally expanded; stalk red-brown, becoming paler upwards, thickened at the base, smooth, subtranslucent; head subglobose or clavate, red, conidiophores branched, branches long, slender, 1·5–2 μ diameter, conidia terminal; conidia ellipsoid or oblong-oval, ends rounded, sometimes slightly attenuated below and subapiculate, continuous, hyaline, 14–18 × 6–8 μ. The stalk may be lacking, and the conidial fructification then takes a *Tubercularia* form.

On elm. Perithecial stage, Elmhurst, 28 December 1852 (Berkeley); Weybridge, August 1856 (Currey); Salisbury, October 1866 (Cooke); Oundle, July 1868 (Berkeley); all in Hb. Kew., with a duplicate of the first in Hb. B.M. Also recorded from Brandon, 14 October 1881 (Plowright), and from Long Ashton (B.M.S.).

Sphaerostilbe flammea Tul., *Sel. Fung. Carp.* I (1861), 130.

Perithecia usually clustered on a well-developed plectenchymatous stroma, bright orange-red, darker round the ostiolum, globose, 0·3 mm. diameter, glabrous, slightly rugose, opaque, usually collapsing centrally, ostiolum minute, conical; asci cylindrical, almost sessile, eight-spored, 90–110 × 8–10 μ, spores obliquely uniseriate; ascospores ellipsoid, obtuse, one-septate, hyaline or yellowish, minutely warted, 12–19 × 5–8 μ.

Conidial stage, *Microcera coccophila* Desm. in *Ann. Sci. Nat.* ser. 3, X (1848), 539; *Atractium flammeum* Berk. & Rav. in *Ann. Mag. Nat.*

Hist. ser. 2, XIII (1854), 461. Synnemata arising from a white or pinkish stroma round the scale, stilboid, up to 2·5 mm. high, more usually clavate or conical, up to 0·6 mm. high, 0·25 mm. diameter, or flattened pulvinate, up to 0·75 mm. long, 0·5 mm. broad, orange-red to blood-red, usually clothed with erect fascicles of hyphae at the base; conidia fusiform, straight, or straight with falcate tips, or slightly curved, up to eleven-septate, 50–105 × 5–7 μ.

On scale insects, usually (in the British Isles) on *Chionaspis salicis* on ash and willow. Perithecial stage, Trengwainton, Penzance, 14 December 1869, Hb. B.M. Conidial stage, Penzance, Hb. Kew. and Hb. B.M.; near Ryde, Isle of Wight, Hb. B.M.

Sphaerostilbe flavo-viridis Fuckel, *Symb. Mycol.* Nachtr. I (1871), 310.

Perithecia superficial, globose with a papillate or subcylindrical apex, 0·27–0·36 mm. high, 0·18–0·3 mm. diameter, yellowish red, then blood-red, finally becoming dark red, apex darker, minutely rugose, glabrous at the apex, rarely collapsing, scattered or gregarious, sometimes arising from a yellow-green mass, sometimes grouped at the base of the yellow-green stilboid conidial stage; asci subcylindrical, 90 × 6–8 μ, or clavate, 70–80 × 9–12 μ, apex at first truncate, spores uniseriate or obliquely uniseriate; paraphyses linear, diffluent; ascospores ovate, or oval, or oblong-oval, ends rounded, one-septate, hyaline, becoming pale brown and minutely warted, 9–14 × 5–7 μ, with a few globose, not septate, 6–10 μ diameter.

Conidial stage, *Atractium flavo-viride* Sacc. Stalk generally simple, acicular, 280 μ high, sparsely floccose at the base, yellowish green, apex paler, with a globose white head; conidia continuous or one-septate, hyaline, oblongo-fusiform, or subclavate, straight or curved, 8·5–17 × 3 μ, or fusiform, curved, three- to seven-septate, 32–50 × 4–4·5 μ. According to Wollenweber, this is *Fusarium melanochlorum* (Casp.) Sacc.

Portbury, January 1845 (Broome), Hb. B.M.; on ash, with *Diplodia* sp., Woodchester, 13 May 1934 (E. W. Mason), Hb. Kew. det. Wollenweber; on elm logs, North Wootton, 1 February 1935; on larch, Worlingham Wood, East Suffolk, April 1936 (E. A. Ellis): Allerthorpe Common, Yorks, September 1937 (W. G. Bramley). Usually associated with a Pyrenomycete, often *Melanomma Pulvis-pyrius* (Pers.) Fuckel.

DIALONECTRIA Cooke in *Grevillea*, XII (1884), 77 and 109

Perithecia superficial, separate, smooth, without a stroma or a continuous subiculum, bright-coloured; asci eight-spored; spores one-septate, hyaline.

Dialonectria Peziza (Tode) Cooke in *Grevillea*, XII (1884), 110; *Sphaeria Peziza* Tode, *Fung. Meckl.* II (1791), 46; *Nectria Peziza* (Tode) Fr., *Summa Veg. Scand.* (1849), 388; *Nectria aurea* Cooke *non* Grev. in *Grevillea*, VIII (1879), 9; *Nectria epigaea* Cooke in *Grevillea*, VIII (1879), 10.

Perithecia superficial, scattered or gregarious, at first globose, then usually collapsing and becoming cup-shaped, 0·25–0·4 mm. diameter, ochre-yellow, then orange or red, at first with pale yellow or white hyphae arising from the sides and base of the perithecium and spreading radially over the substratum, but usually soon becoming naked; asci cylindrico-clavate, 50–90 × 6–10 μ; ascospores broadly ellipsoid, ends rounded, not constricted, thick-walled, one-septate, hyaline, 9–14 × 4·5–6 μ.

On decayed stumps and logs, also on *Polyporus squamosus*. Generally distributed.

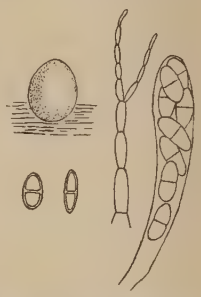

Fig. 9. *Dialonectria galligena*; perithecium, × 30; paraphysis, × 225; ascus, × 450; ascospores, × 450.

Dialonectria sanguinea (Bolt.) Cooke in *Grevillea*, XII (1884), 110; *Sphaeria sanguinea* Bolton, *Fungi Halifax*, III (1789), 121; *Nectria sanguinea* (Bolt.) Fr., *Summa Veg. Scand.* (1849), 388; *Sphaeria Purtoni* Grev. *Scottish Crypt. Flora*, VI (1828), Synopsis, p. 23; *Nectria Purtoni* (Grev.) Currey in *Trans. Linn. Soc.* XXII (1858), 282, fig. 182; *Sphaeria episphaeria* Tode, *Fung. Meckl.* II (1791), 21; *Nectria episphaeria* (Tode) Fr., *Summa Veg. Scand.* (1849), 388.

Perithecia superficial, scattered or gregarious, blood-red, becoming dark red, ovoid or subconoid, apex papillate, often collapsing laterally, smooth, 0·15–0·25 mm. diameter, wall of rather small cells; asci cylindrical, almost sessile, apex truncate, 55–80 × 4–6 μ, spores uniseriate or obliquely uniseriate; ascospores oval or oblong oval, sometimes subfusoid, one-septate, not or slightly constricted, hyaline, becoming pale yellow and minutely granular, 9–14 × 4–6 μ.

On rotten wood and Sphaeriaceous fungi. Generally distributed.

Dialonectria Brassicae (Ellis & Sacc.) Cooke in *Grevillea*, XII (1884), 110; *Nectria Brassicae* Ellis & Sacc. in *Michelia*, II (1881), 374.

Perithecia superficial, scattered or clustered, minute, 0·15–0·18 mm. diameter, blood-red, globoso-conoid or globose with a papillate apex, glabrous, apex hyaline by transmitted light; asci clavate, almost sessile, apex truncate and impressed, 63–75 × 9 μ, spores uniseriate, or biseriate above; no paraphyses; ascospores narrow-oval, often subfusoid, sometimes cymbiform, ends rounded, one-septate, sometimes constricted, hyaline, becoming brownish, 11–18 × 4–6 μ, rarely 9 μ long. [Weese's measurement is 8–13 × 3–4 μ.]

On decaying stalks of *Brassica*. North Wootton, October 1935.

Dialonectria Desmazierii (de Not.) Petch, in *Naturalist* (1937), 281; *Nectria Desmazierii* de Not., *Sfer. Ital.* Cent. I, no. 4 (1863); *Sphaeria*

sanguinea var. *cicatricum* Berk. in *Mag. Zool. Bot.* I (1837), 48; *Sphaeria coccinea* var. *cicatricum* Desm. in *Ann. Sci. Nat.* ser. 3, X (1848), 351; *Nectria cicatricum* Tul., *Sel. Fung. Carp.* III (1865), 77.

Perithecia scattered, superficial, or clustered on a feebly developed hyphal layer which turns black with age, blood-red, minute, conoid or urceolate, 0·18 mm. high, 0·15 mm. diameter, smooth, apex rounded, often collapsing laterally; asci cylindrical, almost sessile, 72–85 × 8 μ; ascospores ellipsoid or oblong, ends rounded, one-septate, upper cell sometimes the broader, hyaline, becoming pale yellow, minutely warted, 9–15 × 4·5–6 μ.

On twigs of box, commonly on the leaf scars. Apethorpe (Berkeley, *British Fungi*, no. 83) Hb. B.M. and Hb. Kew.; Wiltshire (Broome) Hb. B.M.; Overstrand Woods, October 1934; Buckden, September 1936.

Dialonectria galligena (Bres.) Petch, in *Cat. Yorks. Fungi*, (1937) 32; *Nectria galligena* Bres. in Strasser, *Pilzfl. Sonntagbl.* IV (1901), 413.

Perithecia superficial, scattered or densely crowded, sometimes caespitose, orange or pale red (rarely yellow), becoming dark red and finally blackening, globose to ovate, 200–300 μ diameter, smooth, ostiolum papillate, not collapsing; asci clavate, sessile, apex rounded, 72–92 × 9–15 μ; paraphyses stout, branched, somewhat persistent; ascospores fusoid or oval, ends rounded, one-septate, hyaline, becoming pale yellow, 12–27 × 4–9 μ.

Conidial stage, *Fusarium Wilkommii* Lind., pustules erumpent, white, farinose, linear or circular; conidia cylindric or linear-clavate, straight or slightly curved, one- to five-septate, 36–60 × 4 μ.

Distinguished from scattered forms of *Nectria coccinea* by the rounded apex of the ascus and the stout branched paraphyses.

The cause of "canker" on apple and pear trees. Generally distributed. Also on ash, Charminster, Dorset, December 1894, Hb. B.M.; Chilterns, October 1933 (Ehrlich), Hb. Kew. Originally described from specimens on galls on *Salix purpurea*, and recorded in Europe on beech, hazel, and bird-cherry.

Dialonectria graminicola (B. & Br.) Cooke in *Grevillea*, XII (1884), 110; *Nectria graminicola* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, III (1859), 376.

Perithecia superficial, scattered, each on a small, pale brown, basal membrane, globose or ovate, about 0·25 mm. diameter, collapsing and becoming cup-shaped, red, brown when old, smooth, ostiolum papillate, small; asci sessile, fusiform, apex truncate, 50–62 × 8·5–10 μ; ascospores fusoid, ends rounded, one-septate, hyaline, 16–20 × 3·5–4·5 μ.

On dead leaves of *Aira caespitosa*. Batheaston, January 1859 (Broome), Hb. B.M. and Hb. Kew.

Dialonectria arenula (B. & Br.) Cooke in *Grevillea*, XII (1884), 110; *Sphaeria arenula* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, IX (1852), 320; *Nectria arenula* (B. & Br.) Berk., *Outlines* (1860), 394.

Perithecia superficial, usually scattered, ochre-yellow, subglobose or ovate, flattened above, not collapsing, up to 0·3 mm. high, 0·27 mm. diameter, usually with a short, stem-like base, sometimes slightly rough, with a minute, conical ostiolum; asci clavate, 70 × 10 μ; ascospores fusoid, one-septate, rather strongly attenuated downwards, often inequilateral, straight or curved, or oval or subcylindric, 14–20 × 4–6 μ, ends rounded, usually constricted.

On dead leaves of *Aira caespitosa*. Batheaston, February 1851 (Broome), Hb. B.M. and Hb. Kew. The specimen recorded by Bucknall, on dead leaves of *Iris pseudacorus*, near Aust, June 1881, is *Nectriella dacrymycella* (specimen in Hb. B.M.)

Dialonectria Wegeliana (Rehm) Petch, comb.nov.; *Nectria episphaeria* f. *Wegeliana* Rehm in *Hedwigia* (1891), 260; *Nectria Wegeliana* (Rehm) v. Höhn., in Strasser, *Verhandl. zool.-bot. Gesellsch., Wien*, LV (1905), 604.

Perithecia superficial, scattered or clustered, ovoid, apex conicodiscoid, 0·18 mm. diameter, 0·24 mm. high, sometimes collapsing, blood-red, blackening, minutely rugose, smooth round the ostiolum; outer layer of the perithecial wall hyaline, wholly or in part; asci cylindrical or clavate, apex rounded or truncate, sessile, 90–100 × 9–10 μ, spores obliquely uniseriate; paraphyses slender, diffluent; ascospores broadly ellipsoid, ends rounded, one-septate, hyaline becoming brownish and warted, 10–18 × 6–9 μ, with some globose, continuous, 9 μ diameter.

On *Diatrypella* on birch, Wraxall, February 1845 (Broome), Hb. Kew.; on *Diatrypella*, Lytchett, October 1922 (Hawley), Hb. B.M.; on *Diatrypella quercina*, Carlisle, Hb. Kew.; ditto, Logan Woods, near Stranraer, Wigtownshire, August 1936 (C. G. C. Chesters).

Dialonectria Veuillotiana (Sacc. & Roum.) Cooke in *Grevillea*, XII (1884), 110; *Nectria Veuillotiana* Sacc. & Roum. in *Michelia*, II (1881), 325.

Perithecia superficial and densely crowded, urceolate, i.e. globose or ovoid, 0·4–0·5 mm. diameter, 0·5 mm. high, with a flat projecting apical disc, rough with conspicuous warts, yellowish red, becoming scarlet to red-brown, ostiolum minute, scarcely or not projecting; asci cylindrical or clavate, 80–100 × 9–12 μ, apex rounded or subtruncate, spores uniseriate or obliquely uniseriate; paraphyses delicate, linear, diffluent; spores ellipsoid or oval, often inequilateral, hyaline, one-septate, minutely warted, 14–20 × 5–7 μ. Stout, septate, red hyphae, 14–16 μ diameter, spread over the host from the base of the perithecium.

Ralfs 557 in Hb. B.M., without locality; on beech, Knole Park, October 1933 (Ehrlich), Hb. Kew.

LASIONECTRIA Cooke in *Grevillea*, XII (1884), 112

Perithecia and ascospores as in *Dialonectria*, but perithecia hairy or setose.

Lasionectria flavida (Corda) Cooke in *Grevillea*, XII (1884), 110; *Sphaeria flavida* Corda, *Icon. Fung.* IV (1840), 40, fig. 117; *Nectria flavida* (Corda) Fr., *Summa Veg. Scand.* (1849), 388; *Calonectria flavida* (Corda) Sacc. in *Michelia*, I (1878), 313.

Fig. 10. *Lasionectria lecanodes*; perithecium, ×50; ascospores, ×800.

Perithecia superficial, scattered or gregarious, small, 60–120 μ diameter, globose with a minute, conical ostiolum, at first golden yellow, densely clothed with short, yellow tomentum except at the ostiolum, and with longer yellow hyphae extending in strands from the lower half of the perithecium over the substratum and coalescing with those from adjacent perithecia, the perithecial wall gradually turning red from the apex downwards, old and weathered perithecia being red and more or less naked; asci clavate, sometimes cylindrical, apex subtruncate, 40–60 × 6–8 μ, spores obliquely uniseriate or biseriate; paraphyses diffluent; ascospores oblong or subfusoid, inequilateral or subcymbiform, sometimes slightly curved, distinctly one-septate, sometimes slightly constricted, 9–15 × 2·5–3 μ.

On dead wood, Leigh Wood, Bristol, 15 December 1847 (Broome), Hb. Kew. and Hb. B.M.; on bramble, Batheaston, 7 March 1869 (Broome), Hb. Kew. and Hb. B.M.; on sawdust, Langridge, April 1874, Hb. Kew. and Hb. B.M.; on dead wood, Scarborough (Massee), Hb. B.M.; ditto, Missenden, 10 January 1925 (E. J. H. Corner); on decayed wood of beech, Nun Appleton, Yorks, 14 April 1935 (W. G. Bramley).

I have accepted Berkeley and Broome's interpretation of Corda's species, as it appears to fit Corda's description and figure better than any other which has been proposed.

Lasionectria aureola (Winter) Sacc., *Syll. Fung.* IX (1891), 970; *Nectria aureola* Winter in *Hedwigia*, XXIV (1885), 261.

Perithecia gregarious, superficial, minute, globoso-conoid, pale yellow, subtranslucent, covered above with short, rigid, simple, white, spreading hairs; asci oblongo-fusiform, shortly stalked, 47–53 × 7 μ; ascospores fusiform, slightly attenuated and narrowly rounded at the ends, hyaline, one-septate, 14 × 2·5 μ (Winter).

On the mycelium of *Meliola Niessleana* on *Vaccinium Vitis-Idaea*, Killin, Perthshire, July 1907 (D. A. Boyd), Hb. B.M.

Lasionectria lecanodes (Ces.) Petch, comb. nov.; *Nectria lecanodes* Ces. in Rabh. *Herb. Myc.* ed. II, no. 525.

Perithecia superficial, scattered or gregarious, depressed globose, almost discoid when dry, 0·24 mm. diameter, umbilicate, pinkish, clothed with minute, white, erect or decumbent hairs which are up to 40 μ long, 2–3 μ diameter, simple or branched, irregular, con-

torted above and sometimes toothed, with a rounded or globose apex; asci cylindrico-clavate, apex truncate, 60–70 × 5–6 μ; ascospores oval or oblong-oval, ends rounded, hyaline, minutely warted, one-septate, 9–12 × 3–4 μ.

On the thallus of *Peltigera canina*, near King's Lynn, October 1876, 1877, Plowright, *Sphaer. Brit.* III, no. 12, and Cooke, *Fung. Brit. Exsicc.* II, no. 564; North Wootton, 1884 (Plowright) Hb. Kew. On *Lobaria pulmonaria*, Inverary, September 1907 (D. A. Boyd), Hb. B.M.

Lasionectria Leptosphaeriae (Niessl) Petch, comb. nov.; *Nectria Leptosphaeriae* Niessl, in Krieger, *Fung. Sax.* no. 165 (1886).

Perithecia superficial, scattered or in small groups, at first flesh-coloured to brick-red, then dark red, pruinose, globose or broadly conoid, 0·2–0·3 mm. diameter, with a broad, blackish apical disc bearing a minute, conical ostiolum, collapsing, furnished above with short, scattered septate hairs with an ellipsoid terminal cell, and below with hyaline hyphae which spread from the perithecium over the substratum; asci narrow-clavate or cylindrical, almost sessile, apex truncate, 90–125 × 9–13 μ, spores obliquely uniseriate; paraphyses narrow strap-shaped, branched, 2–4 μ broad, diffluent; ascospores hyaline or pale yellow, narrow-oval or fusoid, sometimes subcymbiform, one-septate, ends rounded, 15–22 × 5–6·5 μ.

On the perithecia and mycelium of *Leptosphaeria*. On nettle, Batheaston, November 1861 (Broome); on bramble, Charmy Down, October 1864 (Broome); Little Eaton, July 1910 (Gibbs); all in Hb. B.M., det. Ehrlich. Staunton, October 1862 (Berkeley), Hb. Kew., det. Ehrlich.

NEOHENNINGSIA Koorders, *Bot. Untersuch.* (1907), 164

Perithecia and ascospores as in *Dialonectria*, but perithecia furnished with a ring of more or less horizontal, long, triangular processes round the apex.

Neohenningsia suffulta (B. & C.) v. Höhnel, *Fragm. z. Mykol.* no. 755 (1912); *Nectria suffulta* B. & C. in *Journ. Linn. Soc.* X (1868), 378; *Nectria ornata* Massee & Salmon in *Ann. Bot.* XVI (1902), 75, figs. 29–32.

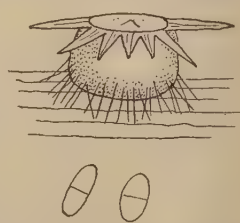

Fig. 11. *Neohenningsia suffulta*; perithecium, × 40; ascospores, × 500.

Perithecia superficial, gregarious, orange-yellow, globose, up to 0·5 mm. diameter, flattened above and furnished at the margin of the flattened area and near it with flat, silvery, spreading scales or tufts of hyphae, 50–110 μ long, 15–25 μ broad; asci cylindrical or cylindrico-clavate, 65–75 × 9–11 μ; ascospores ellipsoid, ends obtuse, one-septate, hyaline, 12–14 × 4–5 μ.

On horse dung, Kew. (Massee and Salmon), Hb. Kew.

NECTRIELLA Nitschke, in Fuckel, *Symb. Mycol.* (1869), 175

Perithecia separate, immersed, then erumpent, bright coloured; ascospores as in *Dialonectria*.

Nectriella dacrymycella Rehm, *Ascomyceten*, no. 232*b*; Thuemen, *Mycoth.* no. 1064.

Perithecia scattered, subepidermal, erumpent, yellow, brownish yellow or reddish, globose, 300–500 μ diameter, with a minute, papillate ostiolum, collapsing and becoming convex; asci clavate, usually with a long pedicel, 65–95 × 9–14 μ, spores obliquely uniseriate or biseriate; ascospores hyaline, fusoid, inequilateral, sometimes curved, one-septate, not constricted, 15–22 × 4–5 μ.

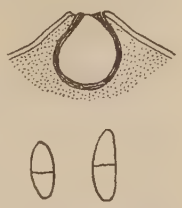

Fig. 12. *Nectriella Robergei*; perithecium in median section, × 50; ascospores, × 600.

On *Iris*, near Aust, June 1881 (Bucknall), Hb. B.M.

Phillips and Plowright (*New and Rare British Fungi*, no. 291) recorded *Nectria dacrymycella* (Nyl.) Karst., collected by Bucknall on *Angelica sylvestris*, Blaize Castle Wood, May 1882. The specimen is not in Hb. Kew. or Hb. B.M., and it is not possible to say what it was, as the description given by Phillips and Plowright was taken, except for one line, from Karsten. Several species have passed under that name, and Weese regards Karsten's fungus as *Nectriella luteola* (Rob.) Weese. On the other hand, Bucknall's specimen on *Iris*, referred by him to *Nectria arenula* B. & Br., is not the latter species, but matches *Nectriella dacrymycella* Rehm in Rehm, *Ascomyceten*, no. 232 *b*.

Nectriella Bloxami (B. & Br.) Fuckel, *Symb. Mycol.* Nachtr. III (1875), 21; *Nectria Bloxami* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, XIII (1854), 467; *Calonectria Bloxami* (B. & Br.) Sacc., *Fung. Veneti*, ser. IV, 23.

Perithecia scattered, subepidermal, erumpent, depressed globose or ovoid, about 0·25 mm. diameter, collapsing, dark red, smooth; asci not seen; ascospores cymbiform, ends broadly rounded, evidently one-septate, 11–16 × 4–4·5 μ.

On dead stems of Jerusalem artichoke, Twycross (Bloxam), Hb. Kew. and Hb. B.M. The type specimens are in poor condition.

Nectriella funicola (B. & Br.) Petch in *Naturalist* (1937) 281; *Sphaeria funicola* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 188; *Nectria funicola* (B. & Br.) Berk., *Outlines* (1860), 393; *Calonectria funicola* (B. & Br.) Sacc. in *Michelia*, I (1878), 312; *Nectriella charticola* Fuckel, *Symb. Mycol.* (1869), 176; *Nectria fibricola* Plowright, apud Sacc. in *Michelia*, II (1880), 152; *Lasionectria funicola* (B. & Br.) Cooke in *Grevillea*, XII (1884), 112.

Perithecia immersed, raising and separating the upper layers of the substratum and becoming partly exposed, scattered or in small groups, dull brown or orange, globose up to 0·36 mm. diameter, convex above, or flask-shaped, or globose with a tubular neck up to

0·3 mm. long, 0·1 mm. diameter, naked, or with the exposed part sparsely covered with short, rigid, spreading, white hairs; hairs up to 50 μ long, 4–5 μ diameter below, hyaline, tapering upwards, thick-walled below, apex obtuse or acute and sometimes shortly encrusted; asci clavate, apex truncate, 90–120 × 9–20 μ; ascospores narrow-oval, often inequilateral, or subcymbiform, one-septate, the lower cell sometimes attenuated, ends rounded, hyaline, 14–22 × 4–6 μ.

On decayed rope, King's Cliffe, October 1841 (Berkeley), Hb. Kew.; on rotting string, King's Lynn, 1881 (Plowright), Hb. B.M.; on old cardboard, Melton Wood, near Cadeby, September 1901 (Massee and Crossland), Hb. Kew.

Nectriella Robergei (Mont. & Desm.) Weese in *Ann. Mycol.* XII (1914), 138; *Nectria Robergei* Mont. & Desm., *Pl. Crypt. France* (1856), fasc. VIII, no. 374; *Nectria lichenicola* (Ces.) Wint. in *Flora* (1872), 523; *Nectria Peltigerae* Phillips & Plowright in *Grevillea*, IV (1876), 123 (223 in error).

Perithecia immersed, scattered, epiphyllous, raising the cortical layer and splitting it stellately, sordid flesh-coloured, pale brownish red, or orange-red, vertically oval, up to 240 μ diameter, 270 μ high, apex rounded; asci clavate, apex truncate, 66–85 × 8–13 μ; ascospores broadly oval, one-septate, wall and septum thin, 10–15 × 4–7 μ, containing numerous small oil globules. [According to Weese (*loc. cit.*), the asci in the type of *Nectriella Robergei* are 45–68 × 9–15 μ.]

Conidial stage, *Illosporium carneum* Fr.

In the thallus of *Peltigera canina*. North Wootton, 13 November 1873 (Plowright), Hb. B.M. and Hb. Kew.; Castle Rising, 1 September 1875 (Plowright), Hb. B.M.; near King's Lynn, November 1875, Plowright, *Sphaer. Brit.* III, 13, and Vize, *Microf. Brit.* no. 388. Also recorded on the same host from Forden by Vize.

HYPHONECTRIA Sacc., *Syll. Fung.* II (1883), 501 (as subgenus) (*Nectriopsis* Maire in *Ann. Mycol.* IX (1911), 323)

Perithecia superficial, separate, on a common byssoid subiculum, bright-coloured, soft; asci eight-spored; ascospores hyaline, one-septate, not apiculate.

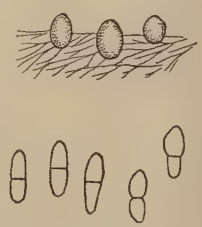

Fig. 13. *Hyphonectria aureonitens*; perithecia, ×30; ascospores, ×800.

Hyphonectria muscivora (B. & Br.) Petch, comb. nov.; *Nectria muscivora* (B. & Br.) Berk., *Outlines* (1860), 394; *Sphaeria muscivora* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 188; *Calonectria muscivora* (B. & Br.) Sacc. in *Michelia*, I (1878), 315; *Sphaeria bryophila* Rob., in Desm. in *Ann. Sci. Nat.* ser. 3, XVI (1851), 306; *Nectria bryophila* (Rob. & Desm.) Sacc. in *Michelia*, I (1878), 296.

Perithecia seated on, or partly embedded in, a white floccose subiculum, scattered or clustered, oval or pyriform,

with a prominent papilla, up to 0·35 mm. high, 0·28 mm. diameter, bright orange, becoming amber when dry; asci clavate, sessile, 80–100 × 12–14 μ; ascospores narrow-oval to subfusoid, sometimes subcymbiform, ends rounded or subacute, one-septate, 15–24 × 6–8 μ.

On mosses on the mud tops of walls in winter, King's Cliffe (Berkeley). Also recorded from Dolgelly (B.M.S.). The record from Hebden Bridge, Yorks, is incorrect.

Hyphonectria violacea (Schmidt) Petch in *Journ. Bot.* LXXV (1937), 220; *Sphaeria violacea* Schmidt, in Fries, *Syst. Myc.* II (1822), 441; *Hypomyces violaceus* (Schm.) Tul. in *Ann. Sci. Nat.* ser. 4, XIII (1860), 14; *Peckiella violacea* (Tul.) Sacc., *Syll. Fung.* IX (1891), 945; *Nectriopsis violaceus* (Schm.) Maire in *Ann. Mycol.* IX (1911), 323; *Byssonectria violacea* (Schm.) Seaver in *Mycologia*, II (1910), 65; *Hypomyces candicans* Plowr. in *Grevillea*, XI (1882), 50; *Nectriopsis candicans* (Plowr.) Maire in *Ann. Mycol.* IX (1911), 323.

Subiculum white, becoming violet; perithecia partly immersed, or wholly immersed except the ostiolum, globose, with a small conical ostiolum, up to 0·2 mm. diameter, wall hyaline to purple-violet; asci cylindrical, 50–60 × 3–4 μ, spores uniseriate or obliquely uniseriate; ascospores oval or oblong-oval, ends rounded, hyaline, smooth, distinctly one-septate when mature, 6–9 × 2–3 μ.

Conidia oval, or linear-oblong, ends obtuse, continuous, sometimes one-septate, 10–22 × 5–7 μ (Tulasne).

Chlamydospores broadly ovate, or oval, 21–30 × 16–25 μ, or globose, 22–24 μ diameter, yellow-brown, thick walled, smooth.

On *Fuligo septica*. Cawdor Castle, September 1879 (Plowright); Leziate, August 1880 (Plowright); Bathford Down, October 1880 (Plowright), Hb. B.M.

Hyphonectria Berkeleyana (Plowr. & Cooke) Petch in *Journ. Bot.* LXXV (1937), 220; *Hypomyces Berkeleyanus* Plowr. & Cooke in *Grevillea*, XI (1882), 48; *Nectriopsis Berkeleyanus* (Plowr. & Cooke) Maire in *Ann. Mycol.* IX (1911), 323.

Subiculum rose-coloured or pallid; perithecia scattered or gregarious, globose, 0·24 mm. diameter, with a papillate ostiolum, scarlet, smooth; asci cylindrical, apex truncate, 66–80 × 5 μ; ascospores uniseriate or obliquely uniseriate, oblong-oval, ends rounded, one-septate, smooth, hyaline, becoming pale yellowish and faintly warted, 7–11 × 4 μ.

On *Stereum hirsutum*, Downton, Herefordshire, October 1878 (Plowright). On *Corticium* sp., Sandringham, November 1878 (Plowright). On *Polyporus* sp., Hb. B.M., sub *Nectria episphaeria*, ex Hb. Bloxam.

Hyphonectria aureo-nitens (Tul.) Petch in *Journ. Bot.* LXXV (1937), 220; *Hypomyces aureo-nitens* Tul., *Sel. Fung. Carp.* III (1865), 64; *Nectriopsis aureo-nitens* (Tul.) Maire in *Ann. Mycol.* IX (1911), 323.

Subiculum golden yellow or white, scanty; perithecia minute,

ovoid, 0·15–0·18 mm. high, 0·12–0·15 mm. diameter, golden yellow or pallid, sparsely clothed with yellow or white hyphae, or almost naked, ostiolum punctate, darker; asci cylindrical or narrow clavate, 90 × 4–7 μ, spores uniseriate or obliquely uniseriate; ascospores oval, narrow-oval, or fusoid, ends rounded or one end subacute, hyaline, minutely warted, 9–13 × 3–4 μ, ultimately becoming constricted at the septum, with the upper cell usually the broader.

Conidial stage, *Gliocladium penicillioides* Cda, *Icon. Fung.* IV, 31; *Verticillium Aspergillus* B. & Br., *Notices of British Fungi*, no. 1384. Conidiophores clustered in small scattered white tufts; stalk stout, 5–6 μ diameter, rigid, minutely verrucose, about 200 μ high, branched in the upper half or third, thickened at the point of origin of the branches; primary branches opposite, sometimes solitary, stout, cylindrical, usually about 20 μ long, but sometimes longer and septate, curving upwards parallel to the main stem; secondary branches in whorls of two to four, cylindrical, about 10 μ long, each bearing an apical cluster of three to five, narrow flask-shaped or conoid phialides of about the same length, all erect, parallel and crowded; conidia oval or subcylindrical, ends obtuse, hyaline, 2–5 × 1·5–2 μ, rarely 7 × 2 μ, collected in an apical globule supported by all the phialides.

On *Stereum hirsutum*, Pwll-y-crochan Wood, North Wales, 11 October 1880 (Plowright), Hb. Kew. and Hb. B.M.; on *Stereum*, Hubberholme, Yorks, 9 September 1936; on *Stereum*, Keld, Yorks, October 1936 (W. G. Bramley).

Hyphonectria Solani (Reinke & Berth.) Petch in *Journ. Bot.* LXXV (1937), 220; *Hypomyces Solani* Reinke & Berth., *Zersetz. d. Kartoffel* (1879), 27.

Subiculum loose, byssoid; perithecia pale purple-red, orange-yellow at the apex, obpyriform; ascospores oblong-oval, ends subacute, one-septate, constricted at the septum, verrucose, 13–16 × 7–8 μ.

On rotting potatoes. Ireland (Pethybridge in *Trans. Brit. Mycol. Soc.* VI (1918) 11).

HYPOMYCES Tulasne in *Ann. Sci. Nat.* ser. 4, XIII (1860), 11 (in part)

Perithecia superficial, separate, on a common byssoid subiculum, bright-coloured, soft; asci usually eight-spored; ascospores hyaline, one-septate, apiculate.

Hypomyces ochraceus (Pers.) Tul. *loc. cit. supra*, p. 12; *Sphaeria ochracea* Pers., *Synopsis* (1801), 18; *Hypocrea apiculata* Peck in *Rep. N.Y. State Mus.* XXIX (1878), 57; *Hypomyces apiculatus* (Peck) Seaver in *Mycologia*, II (1910), 73; *Hypomyces terrestris* Plowr. & Boud. in *Grevillea*, VIII (1880), 105.

Subiculum on the ground, where the affected agaric has decayed, white, then flesh-coloured or peach-coloured, becoming ochraceous

when old and forming compact patches, 1–2 cm. diameter, resembling a *Corticium*; perithecia at first immersed in the stroma, then nearly half-free, crowded, conoid, or subglobose with a conoid apex, 0·3 mm. diameter, yellow or reddish; asci cylindrical, 150–200 × 6–7 μ; ascospores lanceolate or narrow-oval, often inequilateral, apiculate, verrucose, one-septate, becoming constricted when old, hyaline, 27–40 × 6–7 μ.

Conidial stage, *Verticillium agaricinum* Corda (*V. Lactarii* Peck), on the affected agaric, white, effused, even, becoming floccose; conidiophore verticillioid, with branches in whorls of two to four, but often solitary, tapering to the apex; conidia apical, solitary, rarely two or three together, oval, obovate, or oblong, with a broad, truncate apiculus, continuous, 11–21 × 9–12 μ, or globose, 10–13 μ.

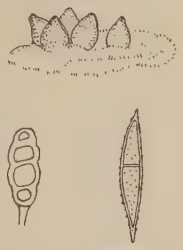

Fig. 14. *Hypomyces aurantius*; perithecia, × 15; chlamydospore, × 250; ascospore, × 800.

Chlamydospores, *Blastotrichum puccinioides* Preuss, produced on the deeper hyphae of the conidial stage, compound, fusoid or narrow-oval, two- to four-septate, strongly constricted, the central cell the largest, apical cell rounded or conoid, 70–140 × 24–33 μ, or oblong-oval, one-septate, 48 × 28 μ, hyaline, becoming reddish purple, smooth (? finally minutely warted), often budding from the central cell.

On *Russula* and *Lactarius*, the conidial and chlamydospore stages on the agaric, but the perithecial stage on the ground, or on vegetable debris, after the agaric has decayed. North Wootton, 1872–80 (Plowright), Hb. Kew.; Leziate, 1880 (Plowright); Ashwicken, Middleton, October 1896 (Plowright), Hb. Kew.; Haslemere, September 1930 (Swanton), Hb. Kew.; Midhurst (Miss Wakefield), Hb. Kew.; Epping Forest, September 1936 (A. A. Pearson). The identity of *H. apiculatus* and *H. terrestris* was determined by Miss Wakefield.

Hypomyces rosellus (A. & S.) Tul., *loc. cit. supra*, p. 12; *Sphaeria rosella* A. & S., *Consp. Fung.* (1805), 38, pl. 7, fig. 3; *Nectria Albertini* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, VII (1861), 452.

Subiculum white, then rose-coloured; perithecia gregarious, globoso-conoid, 0·15 mm. diameter, deep rose-red; asci cylindrical, 150 × 6·5 μ; ascospores lanceolate, straight or curved, apiculate, apiculus sometimes curved, hyaline, one-septate, slightly constricted, verrucose, 22–37 × 5–7 μ.

Conidial stage, *Dactylium dendroides* Fr., conidiophore verticillioid; conidia cylindrico-oblong, obtuse, one- to three-septate, 25–35 × 10–13 μ.

On decaying fungi, most frequently *Stereum hirsutum*. Generally distributed. Plowright, *Sphaer. Brit.* III, no. 4.

Hypomyces aurantius (Pers.) Tul., *Sel. Fung. Carp.* III (1865), 48; *Sphaeria aurantia* Pers., *Synopsis* (1801), 68; *Nectria aurantia* Fr., *Summa Veg. Scand.* (1849), 388; *Sphaeria aurea* Grev., *Scottish Crypt. Flora*, pl. 47 (in part).

Subiculum floccose, ochraceous, often with a white margin; perithecia crowded, globose with a conoid apex, up to 0·3 mm. diameter, 0·36 mm. high, golden yellow or orange, becoming orange-red, then dark red, yellow pruinose; asci cylindrical, 110–140 × 6 μ; ascospores lanceolate, acute, apiculate, usually curved, hyaline, verrucose, one-septate, 18–27 × 4–6 μ.

Conidial stage, *Diplocladium penicillioides* Sacc., conidiophores with a main stem, 4 μ diameter, bearing flask-shaped or conoid phialides, about 30 μ long, in whorls of three at the apex, opposite or solitary elsewhere, with terminal, solitary conidia; conidia oval or oblong-oval, one end apiculate, one-septate, 9–16 × 6–9 μ, hyaline.

Chlamydospores compound, oblong-oval, one- to three-septate, constricted at the septa, pale brown or reddish brown, thick-walled, smooth, 18–48 × 12–18 μ.

On *Polypori* and the tougher *Agaricini*, *Polyporus squamosus*, *P. picipes*, *P. adustus*, *Polystictus versicolor*, *Panus torulosus*, etc. Generally distributed. Berkeley and Broome noted that a very pale, honey-coloured variety, springing from a snow-white subiculum, sometimes accompanied the darker form. There is a specimen of this in Hb. Kew., collected by J. Harvey Bloom at Mickleham, November 1927. In the United States, this form has been named *Hypomyces polyporinus* Peck.

Hypomyces Broomeanus Tul., *Sel. Fung. Carp.* III (1865), 108.

Subiculum white, or pale brown, compact; perithecia ovate, 0·25–0·3 mm. diameter, apex subacute or sometimes produced, hyaline becoming pale brown, densely clothed with white or pale brown, short tomentum, except at the apex, superficial, or immersed through overgrowth of the tomentum; asci cylindrical, 130–140 × 4 μ; ascospores fusoid, one-septate, coarsely warted, usually shortly apiculate at each end, hyaline, 13–16 × 3·5–4 μ.

Conidial stage, *Gliocladium strictum*, n.sp., conidiophores crowded, white in mass, hyaline, about 100 μ high; stem stout, 4 μ diameter below, with few branches, the lower branches usually solitary and distant, the upper branches (phialides) opposite or in whorls of three, about 30 μ long, tapering, all branches parallel to the main stem; conidia hyaline, oblong-oval or narrow-oval, slightly inequilateral, ends obtuse, 5–11 × 2–2·5 μ, the longer ultimately becoming one-septate or pseudo-septate, united by mucus in heads about 14 μ diameter, and ultimately in large masses.

On *Fomes annosus*. Ashton Court, January 1845 (Broome), Hb. B.M.; Staunton, Notts, September 1851 (Berkeley), Hb. Kew. and Hb. B.M.; Lucknam, December 1864 (Broome), Hb. B.M.; Bathford, November, December 1864 (Broome), Hb. B.M. and Hb. Kew., Rabh. *Fung. Europ.* no. 751; Batheaston, 5 November 1877 (Broome), Hb. B.M.; King's Lynn, November 1875, 1876 (Plowright), Hb. Kew. and Hb. B.M., Plowr. *Sphaer. Brit.* III, 5; North Wootton, March 1936; Hubberholme, September 1936.

Hypomyces asterophorus Tul., *Sel. Fung. Carp.* III (1865), 55.

Perithecia crowded among *Nyctalis* chlamydospores, globoso-ovoid, conical above, with a ciliate ostiolum, 150 μ high, 70–90 μ diameter,

hyaline, becoming pale yellow-brown; wall composed of large polygonal cells; asci broadly ovate, four- to six-spored, 40–50 × 18–20 μ; ascospores lanceolate, curved, apiculate, one-septate, pale yellow-brown, 25–35 × 6 μ.

Conidial stage, *Polyscytalum fungorum* Sacc., conidiophore branched; conidia cylindrical, hyaline, catenulate, 10–15 × 3·5 μ.

On *Nyctalis*. Hockering Wood, Norfolk, September 1880 (Plowright).

APIOCREA Sydow in *Ann. Mycol.* XVIII (1920), 186

Perithecia as in *Hypomyces*; ascospores very unequally one-septate.

Apiocrea chrysosperma (Tul.) Syd. in *Ann. Mycol.* XVIII (1920), 186; *Hypomyces chrysospermus* Tul. in *Ann. Sci. Nat.* ser. 4, XIII (1860), 16.

Subiculum golden yellow (from the chlamydospores); perithecia crowded, conoid, up to 0·36 mm. diameter, 0·3–0·32 mm. high, hyaline, becoming orange-yellow, red-brown when dry, smooth; asci cylindrical, or broadly clavate, 120–200 × 4–10 μ; ascospores lanceolate, apiculate at one or both ends, hyaline, very unequally two-celled, one cell sometimes appearing as a small appendage, 21–30 × 5–6 μ, or almost equally two-celled, narrow oval or fusoid, 9–16 × 3–4 μ, rough.

Fig. 15. *Apiocrea chrysosperma*; ascospores of the large-spored and small-spored forms, × 1000.

Conidial stage white, effused; conidia pyriform, or oblong-oval, slightly contracted in the middle, continuous, becoming one- or two-septate, 10 × 5 μ to 30 × 12 μ; conidiophores irregularly verticillioid, often clustered.

Chlamydospores, *Sepedonium chrysospermum* Link, spherical, verrucose, golden yellow, becoming yellow-brown, 10–26 μ diameter.

On *Boleti*, *Paxillus involutus*, *Scleroderma*. Conidial and chlamydospore stages common, perithecia rare. Perithecial stage, Coed Coch (Berkeley), Hb. Kew.; Chapelton Wood near Forres (Stevenson and Plowright), Hb. B.M.; Dartington, Devon (B.M.S.).

Apiocrea Tulasneana (Plowr.) Petch in *Journ. Bot.* LXXV (1937), 220; *Hypomyces Tulasneanus* Plowright in *Grevillea*, XI (1882), 46, pl. 152, fig. 1; *Hypomyces luteovirens* Tul., *Sel. Fung. Carp.* III (1865), 57, pl. 8, figs. 15, 16; *Sphaeria luteovirens* Fr., *Syst. Mycol.* II (1822), 339 (in part); *Peckiella Tulasneana* (Plowr.) Sacc., *Syll. Fung.* IX (1891), 944.

Subiculum sordid yellowish green; perithecia conoid, or subglobose with a cylindrical apex, 0·36–0·5 mm. high, 0·3 mm. diameter, wall yellow, sometimes green at the apex; asci cylindrical, 120–150 × 10 μ;

ascospores lanceolate, inequilateral, or subcymbiform, hyaline, apiculate, coarsely warted, very unequally one-septate, 23–33 × 5–7 μ.

Chlamydospores, *Sepedonium Tulasneanum* Sacc., narrow-oval or oblong, often irregular, base truncate, apex rounded, thick-walled, apex thickened, verrucose, hyaline, then yellow or pale brown, continuous, 18–27 × 7–10 μ.

Conidia oval, continuous, smooth, hyaline, 7–15 × 5–6 μ (Plowright).

On *Boleti*. Laxton, Northants, July 1848 (Berkeley), Hb. Kew. and Hb. B.M.; Mattishall, August, September 1880 (Plowright), Hb. B.M.

PROTOCREA Petch in *Journ. Bot.* LXXV (1937), 219

Perithecia superficial, separate, on a byssoid subiculum, bright-coloured, soft; asci eight-, then sixteen-spored; ascospores at first one-septate, each dividing into two part-spores, hyaline.

Protocrea farinosa (B. & Br.) Petch, *loc. cit.*; *Hypocrea farinosa* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 186.

Subiculum white, byssoid at first, then mealy or shortly tomentose, thin, often extending for several inches; perithecia superficial, or partly immersed in the subiculum, globose or globoso-conoid, 0·18–0·25 mm. diameter, hyaline, becoming amber when old, mealy, collapsing centrally, wall membranous; asci cylindrical, apex truncate, 80–90 × 4 μ, eight- then sixteen-spored; ascospores oblongo-fusoid, or oblong oval, attenuated below, one-septate, the upper cell the broader, 8–10 × 3–4 μ, strongly constricted and dividing into two cuboid or rectangular part-spores, or sometimes subconoid part-spores, which become globose, 3–4 μ diameter, or oval or subrectangular, 4–4·5 × 3 μ, hyaline, minutely warted.

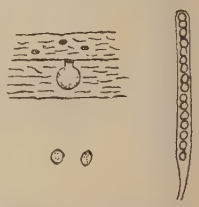

Fig. 16. *Protocrea delicatula*; perithecia in subiculum, ×20; ascus, ×250; part-spores, ×500

On dead wood and decaying fungi. Milton, Northants (Henderson), Hb. Kew. and Hb. B.M.; Bach Hall, Chester, July 1848 (Berkeley), Hb. Kew. and Hb. B.M.; Belvoir, 1854, Hb. Kew. and Hb. B.M.; Castle Rising, September 1881 (Plowright), Hb. Birmingham; Taunton, 20 September 1911 (J. W. Ellis), Hb. Kew.; Ranmore, 10 May 1936 (E. W. Mason). In the specimen from Ranmore, the part-spores are markedly subconoid, and show an approach to *Hypocrea stipata* (Libert) Fuck., but they are not apiculate, as in the latter species.

Protocrea delicatula (Tul.) Petch, *loc. cit.*; *Hypocrea delicatula* Tul., *Sel. Fung. Carp.* III (1865), 33.

Subiculum cream-coloured, byssoid, thin, effused, readily separable from the substratum, somewhat spongy, minutely tomentose, studded with fawn-coloured perithecia; perithecia partly immersed

in the subiculum, or nearly entirely immersed with only the ostiolum projecting, globose, 180 μ diameter, with a subcylindrical ostiolum about 40 μ high, 50 μ diameter, wall membranous, reddish; asci cylindrical, 70 × 4 μ; part-spores cuboid, becoming globose, 2·5–3 μ diameter, or oval, 3–4 × 2·5–3 μ, hyaline, minutely warted.

On dead coniferous wood. Fir plantations, Lucknam, April 1866 (Broome), Hb. Kew. and Hb. B.M., the only British collection.

RHYNCHONECTRIA von Höhnel, *Fragm. z. Mykol.* no. 32 (1903)

Perithecia superficial, separate, soft, pallid or bright-coloured, elongated, with an acute ostiolum; asci four- or eight-spored; ascospores hyaline, fusiform, one-septate, with a cilium at each end.

Rhynchonectria longispora (Phil. & Plowr.) v. Höhn., *Fragm. z. Mykol.* no. 32 (1903); *Eleutheromyces longisporus* Phil. & Plowr. in *Grevillea*, XIII (1885), 78; *Eleutherosphaeria longispora* (Phil. & Plowr.) Grove in *Journ. Bot.* XLV (1907), 171.

Perithecia superficial, crowded, elongated, whitish yellow, 0·45–0·5 mm. high, 0·2 mm. diameter at the base; ostiolum acutely pointed, composed of converging, narrow, parallel cells; asci elongato-clavate or subfusiform, 130–150 × 20–25 μ, usually four-spored; ascospores hyaline, elongated fusiform, acute, one-septate, with a cilium at each end, 50–60 × 5–8 μ.

On *Cribraria* (Myxomycetes), Holt House Wood, near King's Lynn, September 1882 (Plowright); on a Myxomycete, Studley, July (Grove)? No specimens available.

LETENDRAEA Sacc. in *Michelia*, I (1877), 43

Perithecia superficial, separate, soft, bright-coloured; ascospores one-septate, hyaline, becoming brown.

Letendraea helminthicola (B. & Br.) Weese in *Mitt. Bot. Tech. Hochsch. Wien*, I (1924), 59; *Nectria helminthicola* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, III (1859), 375; *Calonectria helminthicola* (B. & Br.) Sacc. in *Michelia*, I (1878), 315; *Letendraea eurotioides* Sacc. in *Michelia*, II (1880), 73.

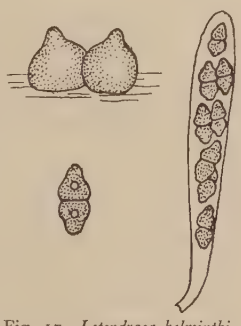

Fig. 17. *Letendraea helminthicola*; perithecia, × 50; ascus, × 500; ascospore, × 660 (after Richon).

Perithecia minute, scarcely visible to the naked eye, superficial, solitary or in small groups, flesh-coloured becoming pale yellow, globose or slightly ovoid, with a small papilla, 100–160 μ diameter, smooth, glabrous; asci clavate, thick-walled, almost sessile, eight-spored, 60–70 × 10–14 μ; ascospores oblongo-

fusoid, ends rounded, one-septate, generally constricted at the septum and unequally septate, thin-walled, smooth, pale brown, 12–15 × 4·5–6 μ.

Parasitic on *Helminthosporium appendiculatum* (? and on other species of *Helminthosporium*). Batheaston, January 1859 (Broome), Rabenhorst, *Fung. Europ. Exsicc.* no. 47; Forden, February 1878 (Vize), Plowright, *Sphaer. Brit.* III, no. 10.

CALONECTRIA de Not., *Comm. Critt.* II (1867), 477

Perithecia superficial, separate, bright-coloured (not blue); ascospores oblong, oval, or fusoid, hyaline, two- or few-septate.

Calonectria erubescens (Rob.) Sacc. in *Michelia*, I (1878), 309; *Sphaeria erubescens* Rob. in Desm. *Ann. Sci. Nat.* ser. 3, VI (1846), 72.

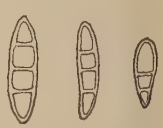

Fig. 18. *Calonectria tessellata*; ascospores × 500.

Perithecia scattered or in small groups, superficial, sometimes with a small rosette of white hyphae at the base, rose-coloured, then brick-red, finally brownish red, globose, about 0·3 mm. diameter, with a minute, papillate ostiolum, almost smooth, collapsing; asci fusoid, 42–65 × 8–12 μ; ascospores hyaline, fusoid or cymbiform, straight or curved, three-septate, 16–22 × 3–4 μ.

On holly leaves. Clifton Downs, October 1879 (Bucknall), Hb. Kew.; Saltash (Rev. J. H. Adams).

Calonectria ochraceo-pallida (B. & Br.) Sacc., *Fungi Veneti*, ser. iv, 23 (1875); *Sphaeria ochraceo-pallida* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 187; *Nectria ochraceo-pallida* (B. & Br.) Berk., *Outlines* (1860), 394; *Nectria ochraceo-pallida* var. *corallina* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, XIII (1854), 467; *Calonectria Plowrightiana* Sacc. in *Michelia*, I (1878), 307; *Nectria Plowrightiana* (Sacc.) Phil. & Plowr. in *Grevillea*, VIII (1880), 105.

Perithecia scattered or gregarious, superficial, ochre-yellow, sometimes orange-red or pale red, globose, up to 0·35 mm. diameter, slightly flattened above, with a minute papillate ostiolum, slightly darker round the ostiolum, smooth; asci clavate or fusiform, 80–100 × 14–22 μ, spores obliquely uniseriate, or biseriate, or more or less in a parallel bundle; the smaller spores cymbiform, the longer cylindric or fusoid, straight or slightly curved, obtuse, hyaline, three- to eight-septate, usually 22–50 × 4–6 μ, sometimes up to 90 × 5 μ.

On elm, Rockingham Forest (Berkeley), Hb. B.M.; on elder, Gopsall (Bloxam), Hb. B.M.; on elm, King's Cliffe, January 1853 (Berkeley), Hb. Kew.; on hawthorn, Batheaston, 26 February 1877 (Broome), Hb. B.M.; on elm, Mossburnford (A. Jerdon), Hb. Kew.; on poplar, Penzance, Hb. Kew.; on beech, Carlisle, Hb. Kew.; on dead stems of *Arctium Lappa*, near Shrewsbury, February 1878 (Phillips and Plowright), Plowright, *Sphaer. Brit.* III, no. 15; on *Arctium Lappa*, Mulgrave Woods, September 1912, Hb. B.M.; on elm, King's Lynn, Plowright, *Sphaer. Brit.* III, no. 9; Cooke, *Fung. Brit. Exsicc.* ser. I, no. 665.

Calonectria tessellata Petch, n.sp.

Perithecia scattered or crowded, superficial, dull orange when moist, brownish yellow when dry, conoid or ovoid, up to 0·3 mm. high, 0·25 mm. diameter, sometimes collapsing centrally, minutely rugose, glabrous, or with a few projecting cells or small warts at the apex, ostiolum naked, slightly darker; wall with an outer layer of large cells which give the perithecium a rugose or tessellated appearance under a medium magnification, brownish yellow by transmitted light; asci clavate, eight-spored, sessile, apex truncate, 75–95 × 12–18 μ, spores obliquely uniseriate or biseriate; ascospores hyaline, three-septate, oval or oblong-oval, sometimes inequilateral, straight, ends rounded, 18–26 × 7–9 μ.

On decaying stalks of *Brassica*, North Wootton, November 1935; on dead apple twig, Camberley, November 1920, Hb. B.M.

Differs from *C. ochraceo-pallida* in its shorter, broader ascospores, and in the structure of the perithecium wall.

Calonectria minutissima Grove in *Journ. Bot.* LXVIII (1930), 31.

Perithecia almost globose, 80–100 μ diameter, somewhat pallid, very translucent, almost glabrous, with a small papilla, thin-walled; asci lanceolate, attenuated above and below, usually curved, 40 × 5 μ, spores eight, sometimes fewer, biseriate; spores hyaline, fusoid, bent or curved, either end acute or one end subobtuse, 20–22 × 1·5 μ, continuous, containing seven to nine guttae (*ex* Grove, *loc. cit.*).

On dead culms of *Heleocharis palustris* in marshes near Aldrige, Staffs, September (Grove).

Calonectria platasca (Berk.) Sacc. in *Michelia*, I (1878), 308; *Sphaeria platasca* Berk., *Eng. Fl.* V (1836), 263; *Nectria platasca* Berk., *Outlines* (1860), 393.

"Scattered, perithecia orange globose confluent with the subobtuse ostiolum, base immersed. On the soft wet decayed stump of a maple which had been broken off. Winter. Rockingham Forest, Norths. Rev. M. J. Berkeley.—Perithecia globose, but tapering above into the ostiolum, which varies somewhat in length, so as to have a slightly ovate appearance, immersed in the soft white wood almost to the base of the ostiolum, of the same colour as *Peziza aurantia*, with now and then a few indistinct filaments. Asci broad above, like those of the following species [*Sphaeria affinis* Grev.]. Sporidia oblong, divided into four articulations, each containing a nucleus" (Berkeley, *loc. cit.*).

Nothing further is known about this species. The type in Hb. Kew., from Morehay Lawn, Northants, does not appear to contain any perithecia now. The description suggests a *Cesatiella*, but Berkeley labelled his herbarium specimens, *Nectria Peziza* var. *platasca*.

GIBBERELLA Sacc. in *Michelia*, I (1877), 43

Perithecia superficial, separate, caespitose on an erumpent, parenchymatous stroma, or scattered, soft, appearing brown, dark blue, or black, but the perithecial wall blue or violet by transmitted light; ascospores hyaline (sometimes pink in mass), ovoid or fusoid, two or few septate (usually three- to five-septate).

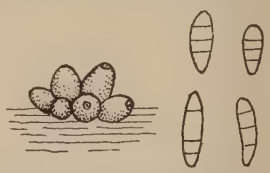

Fig. 19. *Gibberella pulicaris*; perithecia, × 25; ascospores, × 500.

Gibberella pulicaris (Fr.) Sacc. in *Michelia*, I, (1877) 43; *Sphaeria pulicaris* Fr. in Kunze & Schm., *Mycol. Hfte.* II (1823), 37.

Perithecia caespitose in pulvinate or irregular heaps on a brown stroma, or scattered and solitary, up to 0·3 mm. diameter, globose, conoid, or ovoid, collapsing, at first rufous, then appearing black, but the wall dark violet-blue by transmitted light, rugose, wall leathery, wrinkled and appearing warted when dry, ostiolum minute, papillate; asci subcylindrical or clavate, almost sessile, 75–105 × 11–15 μ, apex at first truncate, becoming rounded, spores obliquely uniseriate or biseriate; ascospores oblong-oval or narrow-oval, sometimes fusoid, inequilateral, straight or curved, ends rounded, three-septate, hyaline, smooth, slightly constricted at the septa, 16–24 × 6–9 μ.

On branches and stems of woody and herbaceous plants. Generally distributed. On elder, broom, and *Brassica* stalks, North Wootton. On *Pteris*, Lyndhurst, August 1885, Hb. Kew.

Gibberella cyanogena (Desm.) Sacc., *Syll. Fung.* II (1883), 555; *Sphaeria cyanogena* Desm. in *Ann. Sci. Nat.* ser. 3, X (1848), 352; *Gibberella Saubinetii* (Mont.) Sacc. in *Michelia*, I (1879), 513; *Gibbera Saubinetii* Mont., *Syll. Crypt.* (1856), 252; *Sphaeria Saubinetii* Dur. & Mont. in *Fl. Alger.* I (1869), 479.

Perithecia scattered, or crowded in flat groups on an inconspicuous brown stroma, up to 0·25 mm. diameter, conoid, or subcylindric, or ovoid and contracted below, collapsing, at first green by transmitted light when fresh, then appearing black, but the wall at first pale blue, then violet-blue, by transmitted light, rugose, covered with large cellular warts, wall thin, ostiolum minute, papillate; asci broadly clavate, with a stout pedicel, 70–100 × 11–18 μ, apex at first truncate, then rounded or acuminate, spores obliquely uniseriate, then biseriate; ascospores narrow-oval, fusoid, or cymbiform, ends rounded, straight or slightly curved, three-septate, rarely four- or six-septate, hyaline, smooth, 20–36 × 5–7 μ, rarely 8 μ broad, becoming inflated between the septa on germination.

On decaying herbaceous stems. Common on decaying stalks of *Brassica*. On *Brassica*, Batheaston, October 1855 (Broome), Hb. B.M.; etc. Also on elm, Batheaston, April 1854 (Broome), Hb. B.M.; on broom, Norwich, October 1934; on elder, North Wootton, November 1935.

Gibberella Zeae (Schw.) Petch in *Ann. Mycol.* XXXIV (1936), 260; *Sphaeria Zeae* Schw., *Fung. Car. Super.* no. 234 (1822); Fries, *Syst. Mycol.* II (1823), 527, and III (1829), 232.

Perithecia minute, scattered, or crowded in small, flat groups, usually not united, superficial, without a stroma, subglobose, or ovoid, or conoid, up to 0·25 mm. high, 0·18 mm. diameter, sometimes attached by a broad base, sometimes by a central point, collapsing, appearing black, but the wall violet-grey or smoky blue by transmitted light, bearing, usually on the upper half, rather loose, scattered, small, cellular warts, wall thin, ostiolum minute, papillate; asci clavate, 55–90 × 9–13 μ, apex truncate, then rounded, spores obliquely uniseriate, then irregularly biseriate; ascospores narrow-oval or cymbiform, straight or slightly curved, three-septate, hyaline, smooth, 18–27 × 4–5 μ.

On stems, etc., of Gramineae, especially cereals. Cockle Park, Northumberland (Dr F. T. Bennett).

Gibberella Buxi (Fuckel) Wint. in *Rabh. Krypt.-Fl.* II (1887), 103; *Gibbera Buxi* Fuckel, *Symb. Mycol.* Nachtr. II (1873), 32; *Lisea Buxi* (Fuckel) Sacc., *Syll. Fung.* II (1883), 518.

Perithecia solitary or in small groups, superficial, conoid, 0·24 mm. high, 0·2 mm. diameter, sometimes collapsing and becoming cup-shaped, smooth, appearing black, but the wall dark violet by transmitted light; asci sessile, broadly clavate, 66 × 15 μ; ascospores oval or oblong-oval, ends rounded, hyaline, one- or three-septate, slightly constricted, 13–20 × 6–8 μ.

On twigs of *Buxus*, with *Dialonectria Desmazierii*, Overstrand Woods, October 1934.

Gibberella acervalis (Moug.) Sacc. in *Michelia*, I (1878), 318; *Sphaeria acervalis* Mougeot, in Fries, *Elench. Fung.* II (1828), 83.

Perithecia caespitose in small groups on an erumpent stroma; stroma plectenchymatous or byssoid, subepidermal, then erumpent; perithecia black, minutely rugose, globose, ovoid or conoid, about 0·25 mm. diameter, collapsing centrally; wall thin, with thicker areas in the upper part, purple-brown or purple-violet by transmitted light; asci cylindrico-clavate, sessile, 80 × 9–13 μ; ascospores narrow-oval or oblong-oval, ends rounded, usually symmetrical, three-septate, 14–22 × 6–7 μ, or ellipsoid or narrow-oval, one-septate, 11–18 × 5–6 μ.

On dead branches of *Salix caprea*, Shelton, Norfolk, February 1873 (Plowright), Hb. B.M. Plowright's specimen is immature, but it appears to be correctly named.

ACTINIOPSIS Starbäck in *Bih. K. Svensk. Vet.-Akad. Handl.* xxv, Afd. III (1899), 54

Perithecia with an apical disc, fringed with spreading triangular fascicles of hyphae, as in *Neohenningsia*; ascospores three- or more septate.

Actiniopsis peristomialis (B. & Br.) Petch, comb. nov.; *Peziza* (*Mollisia*) *peristomialis* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, XVIII (1866), 126; *Cyathicula peristomialis* (B. & Br.) Sacc., *Syll. Fung.* VIII (1889), 308; *Peristomialis Berkeleyi* Boud., *Discom. d'Europe* (1907), 116.

Fig. 20. *Actiniopsis peristomialis*; ascospores, × 600.

Perithecia at first globose, then subcylindrical, ovoid, or pyriform, apex truncate, 300–400 μ high, 200 μ diameter, pallid, furnished at the margin of the apical disc with long, white, triangular teeth, wall stout; asci subcylindrical or clavate, 80–90 × 10 μ, spores obliquely uniseriate, then biseriate; paraphyses stout, apex thickened, diffluent; ascospores hyaline, fusiform, inequilateral, subacute, three to five-septate, 20–27 × 4–5 μ.

On dead bark of holly, Penzance (J. Ralfs), Hb. Kew.

PARANECTRIA Sacc. in *Michelia*, I (1878), 317

Perithecia membranous, subpapillate; ascospores hyaline, three-septate, each end produced into a cilium.

Paranectria affinis (Grev.) Sacc., *loc. cit.*; *Sphaeria affinis* Grev., *Scottish Crypt. Flora*, pl. 186, fig. 1 (1826); *Nectria affinis* (Grev.) Cooke in *Mycologia Scotica* (1879), 362 and *Grevillea*, VIII, 9.

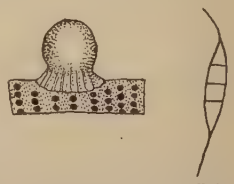

Fig. 21. *Paranectria affinis*; perithecium on the lichen thallus (after Greville), × 30; ascospore, × 400.

Perithecia superficial, scattered or clustered, orange-coloured, globose, 0·25–0·3 mm. diameter, attached by white mycelium from which a few lax hyphae extend over the perithecium, membranous, wall about 20 μ thick, ostiolate, the ostiolum not, or slightly, elevated; asci at first oblongo-clavate, with spores obliquely uniseriate, 40–45 × 12–14 μ, becoming ovate, 18 μ diameter, with spores in a parallel bundle, eight-spored; ascospores hyaline (or pale yellow?), three-septate, fusoid, sometimes inequilateral, the central part 24–34 × 6–8 μ, attenuated at each end into a slender seta up to 15 μ long, the upper usually curved, the lower straight.

On *Ephebe lanata* Wainio. Appin (Carmichael), Hb. Kew.

CESATIELLA Sacc., *Michelia*, I (1878), 250

Perithecia immersed, separate, soft, pale coloured, ostiolum papillate; ascospores hyaline, two- or more septate.

Cesatiella lancastriensis Grove in *Journ. Bot.* LXVIII (1930), 132.

Perithecia scattered or gregarious, immersed, erumpent, about 500 μ diameter, colourless, glabrous, soft, narrowly ovoid, apex papillate, obtuse; asci cylindrical or clavato-fusoid, long-stalked, 100–160(+) × 12 μ, spores biseriate; ascospores hyaline, fusoid, acute, five-, perhaps seven-septate, 35–44 × 4–5 μ; paraphyses very numerous, filiform (Grove, *loc. cit.*).

Fig. 22. *Cesatiella*; perithecium in section; ascospore (diagrammatic, after Saccardo).

In wet, rotting wood covered with algae, Ainsdale, Lancs, September–December 1928 (Grove).

ORCADIA Sutherland in *Trans. Brit. Mycol. Soc.* V (1914), 151

Perithecia immersed, separate, soft, pallid, with a long beak; ascospores hyaline or yellowish, cylindrical, three-septate.

Orcadia Ascophylli Sutherland, *loc. cit. supra*, pl. 3, fig. 3.

Perithecia entirely immersed, spherical, 160–200 μ diameter, with a long, wide, cylindrical beak, 80–125 μ long, 35 μ wide; asci clavate, 65–75 × 8 μ; paraphyses few, linear, apex slightly inflated; ascospores pale yellow, cylindrical, slightly curved, three-septate (dimensions not given).

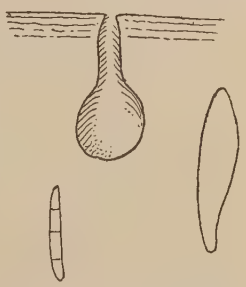

Fig. 23. *Orcadia Ascophylli*; perithecium (in section), ascus, and ascospore (after Sutherland.)

In the thallus of *Ascophyllum nodosum*, Orkney.

Orcadia pelvetiana Sutherland in *New Phytol.* XIV (1915), 183, fig. 1.

Perithecia entirely immersed, globose, 110–140 μ diameter, with a cylindrical or tapering beak, 160–180 μ long, 20–30 μ wide; asci clavate, or fusiform and curved, 50–65 × 11–13 μ; paraphyses diffluent; ascospores fusiform, curved, about 40 × 4–5 μ, three-septate, yellowish.

In the thallus of *Pelvetia canaliculata*, Orkney, and Clare Island.

BARYA Fuckel, *Symb. Mycol.* (1869), 93

Perithecia superficial, conoid or flask-shaped, separate, bright-coloured, soft, sometimes seated on a byssoid subiculum; asci elongated cylindrical or lanceolate, capitate; ascospores hyaline, linear, continuous, almost as long as the ascus.

Barya aurantiaca Plowr. & Wilson in *Gard. Chron.*, 9 February 1884, 176, figs. 32–4; *Claviceps Wilsoni* Cooke in *Grevillea*, XII, 77 (March 1884); *Claviceps purpurea* var. *Wilsoni* W. G. Sm., *Diseases of Field and Garden Crops* (1884), 233–8, figs. 107–11.

Subiculum white, floccose, becoming compact; perithecia almost superficial, conoid or flask-shaped, 0·25–0·3 mm. high, 0·12 mm. diameter, yellow, ostiolum orange; asci cylindrical, 200–250 × 3 μ; ascospores filiform, flexuous, continuous, almost as long as the ascus. Conidiophores spicarioid (?); conidia narrow-oval or lanceolate, ends acute, 10–12 × 2–3 μ.

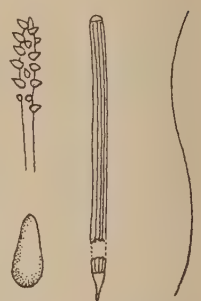

Fig. 24. *Barya aurantiaca*; perithecia on *Claviceps*, × 6; a single perithecium, × 40; ascus and spores, × 660; ascospore, × 200.

On *Claviceps purpurea* (Fr.) Tul. on ergot of *Glyceria fluitans*, near Aberdeen, July 1882 (A. S. Wilson), Hb. Kew.

OPHIONECTRIA Sacc. in *Michelia* I (1878), 323

Perithecia superficial, separate, bright-coloured, sometimes clustered on a feebly developed, parenchymatous stroma; asci clavate, apex sometimes thickened; ascospores cylindrical or elongated fusoid, hyaline, multiseptate.

Ophionectria cylindrospora (Sollm.) Berl. & Vogl., *Add. Syll. Fung.* (1886), 217; *Nectria cylindrospora* Sollm. in *Bot. Zeit.* XXII (1864), 265.

Perithecia in small clusters on a feebly developed stroma within the bark, barely erumpent, globose, up to 0·3 mm. diameter, pale red, becoming dark red, blackening, encrusted with resinous particles and scales, collapsing and becoming cup-shaped; asci clavate or broadly clavate, 75–90 × 8–20 μ, containing long cylindrical spores, or minute rod-like spores, or a mixture of the two; ascospores cylindrical, ends obtuse, or attenuated below, straight or curved, closely multiseptate, 22–40 × 3–4 μ; minute spores cylindrical, ends rounded, straight or curved, 2–4 × 0·75 μ.

Fig. 25. *Ophionectria cylindrospora*; ascospore, × 500.

On branches of *Pinus*. Lytchett, April 1922 (Hawley), Hb. B.M. On *Pinus Strobus*, Windsor Great Park, April 1935 (Ehrlich), Hb. Kew.

TRICHONECTRIA Kirschst. in *Verhandl. Bot. ver. Brand.* XLVIII (1906), 60

Perithecia superficial, solitary, or caespitose in small numbers, soft, bright-coloured, covered with long, spreading, hyaline setae; ascospores fusoid, hyaline, multiseptate.

Trichonectria hirta (Blox.) Petch in *Naturalist* (1937) 282; *Nectria hirta* Bloxam, in Currey, *Trans. Linn. Soc.* XXIV (1863), 158; *Calonectria hirta* (Blox.) Sacc. in *Michelia*, 1 (1878), 307; *Lasionectria hirta* (Blox.) Massee in *Grevillea*, XV (1886), 8; *Calonectria vermispora* Mass. & Crossl. in *Naturalist*, January 1904, 4; *Dialonectria vermispora* Mass. & Crossl., *Fungus Flora Yorks* (1905), 214.

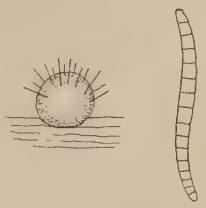

Fig. 26. *Trichonectria hirta*; perithecium, ×40; ascospore, ×350.

Perithecia superficial, scattered or gregarious, minute, globose with a slightly prominent ostiolum, or globoso-conoid, 0·1–0·25 mm. diameter, "pinkish salmon colour", pallid when dry, covered with prominent white setae; setae hyaline, up to 110 μ long, 8 μ diameter below, tapering upwards, apex obtuse, slightly bulbous at the base, thick-walled below, solid above; asci soon diffluent, thin-walled, 14 μ diameter, apex rounded and not thickened; ascospores fusoid, straight or curved, or vermiform, ends obtuse, hyaline, multiseptate, 48–95 × 5–9 μ.

On decaying fence rails, Twycross (Bloxam), Hb. Kew. and Hb. B.M. On a decorticated log, Hardcastle, near Hebden Bridge, Yorks (Crossland), Hb. Kew.

TORRUBIELLA Boudier in *Rev. Mycol.* (1885), 227

Perithecia superficial, bright-coloured, membranous, sessile on a subiculum; asci linear, cylindrical, capitate; ascospores filiform, very long, septate, dividing into short part-spores, hyaline.

Torrubiella aranicida Boud., *loc. cit.*

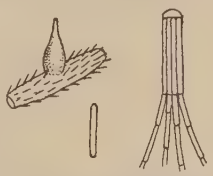

Fig. 27. *Torrubiella aranicida*; perithecium on spider's leg, ×12; apex of ascus and ascospores, ×1000; part-spore, ×1000.

Subiculum scanty, white; perithecia flask-shaped or elongated conoid, up to 0·7 mm. high, 0·25–0·35 mm. diameter, hyaline when fresh, becoming ochraceous or orange ochraceous when dry, straight or curved, glabrous; asci linear, very long, cylindrical, capitate, 250–350 × 3–4 μ, four- or eight-spored; ascospores linear, very slender, almost as long as the ascus, 0·5–1 μ diameter, at first obscurely multiguttulate, then multiseptate with septa 8–16 μ apart, ultimately dividing into rod-shaped part-spores, 8–16 μ long.

On spiders under moss. Hubberholme, Yorks, 8 September 1936.

TRAILIA Sutherland in *Trans. Brit. Mycol. Soc.* v (1914), 149

Perithecia totally immersed, separate, pale coloured, soft, with a long beak; asci cylindrical, curved, eight-spored, without paraphyses; ascospores hyaline, linear clavate, bent double and coiled in the ascus, multiseptate.

Trailia Ascophylli Sutherland, *loc. cit.* pl. 3, fig. 2.

Perithecia gregarious, spherical or clavate, 50–60 μ diameter; beak cylindrical, straight or curved, 300–450 μ long, 7·5–10 μ diameter; asci 45–50 × 9–10 μ; ascospores narrow-clavate, tapering from 3–3·5 μ to 1 μ, hyaline, multiseptate, twice the length of the ascus (Sutherland).

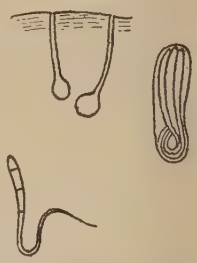

Fig. 28. *Trailia Ascophylli*; perithecia, ascus and ascospore (after Sutherland).

In dark patches on *Ascophyllum nodosum*, Orkney.

PLEONECTRIA Sacc., *Fungi Veneti nov.* ser. v, no. 178

Perithecia caespitose on a parenchymatous stroma or scattered, soft, bright-coloured; ascospores hyaline, muriform.

Pleonectria berolinensis Sacc. in *Michelia*, i (1878), 123; *Nectria Ribis* Rabenh., *Fung. Europ.* no. 247.

Perithecia erumpent, superficial, united in pulvinate groups, depressed globose, soon umbilicate-scutate, 0·3–0·5 mm. diameter, brick-red, ostiolum impressed; asci cylindrical, subsessile, 90–100 × 10 μ, apex truncate, spores uniseriate; ascospores ovato-oblong, ends obtuse, muriform, with seven cross walls, not constricted, hyaline, 18–20 × 8 μ (Saccardo, *loc. cit.*).

Fig. 29. *Pleonectria berolinensis*; ascospore, × 750.

On dead branches of *Ribes* spp. Specimen in Hb. Kew., ex Hb. Cooke, sub *Nectria cinnabarina*, without name of host, date, or locality, but marked "British Fungi. M. C. Cooke"; det. Ehrlich.

HYPOCREACEAE

POLYSTIGMA DC. in *Comment. Mus. Hist.* iii (1817), 330

Stroma fleshy, immersed in the leaf of the host, bright-coloured, circular or effused; perithecia immersed; ascospores hyaline, ovoid, continuous.

Polystigma rubrum (Pers.) DC., *loc. cit. supra*, 337; *Xyloma rubrum* Pers., *Observ.* ii (1799), 101; Purton, *Midland Flora*, iii (1821), 316; Greville, *Fl. Edin.* (1824), 365; Greville, *Scottish Crypt. Flora* (1824), pl. 120; *Dothidea rubra* Pers., Berkeley, *English Flora*, v (1836), 286.

Stromata generally scattered over the leaf, slightly thicker than the leaf, slightly arched, reddish yellow, fleshy, punctate with the ostiola of the pycnidia, subsequently (on the fallen leaves) strongly arched, concave above, almost black, brittle, brown internally; pycnidia immersed, spherical, chambered below, ostiolum small, papillate; pycnospores hyaline, linear, hook-shaped above, about 30 μ long; perithecia immersed, almost spherical, ostiolum slightly projecting; asci oblongo-clavate, long-stalked, 78–87 (sporiferous part, 45–50) × 10–12 μ, eight-spored; ascospores ellipsoid, continuous, hyaline, 11–13 × 4·5 μ.

Fig. 30. *Polystigma rubrum*; affected leaf, natural size; cross-section of stroma, ×6; pycnospore, ×450; ascospore, ×660 (after Tulasne).

On the leaves of *Prunus spinosa* and *Prunus insititia*. Common. Occurs also in Central Europe on *Prunus domestica*, and has been reported on that host from Thirsk, Yorks, in *Fungus Flora Yorks.*

Polystigma ochraceum (Wahlenb.) Sacc., *Conspectus Pyrenom.* (1875), 20; *Sphaeria ochracea* Wahlenb., *Flora Lapponica* (1812), 518; *Dothidea fulva* Holl. & Schm., Berkeley, *English Flora*, v (1836), 286.

Stromata circular or somewhat irregular, slightly arched, up to 1 cm. diameter, ochre-yellow, or golden yellow, becoming brownish red, closely punctate with the darker ostiola; in other respects, similar to *Polystigma rubrum*, but somewhat larger in all its parts; asci 95–105 × 14 μ; ascospores 14 × 5–5·5 μ.

On leaves of *Prunus Padus*. "Not uncommon in Scotland" (Berkeley, *loc. cit.*): recorded for Dee and Moray in *Mycologia Scotica* (1879). "Highland Woods" (Klotzsch.), Hb. Kew.; without locality, Cooke, *Fungi Brit. Exsicc.* II, 578; near Aberdeen, 1869, Cooke, *Fungi Brit. Exsicc.* no. 564; Inellan, 1873 (R. H. Paterson), Hb. Kew.; Perth (J. B. White), Hb. Kew.

SELINIA Karsten in *Medd. Soc. Flora Fauna Fennica*, 1 (1876), 57

Stromata partly immersed, floccose, elliptic or wart-like, becoming confluent and irregular, bright-coloured, minutely tomentose; perithecia immersed; asci four- or eight-spored; ascospores ellipsoid, hyaline, continuous.

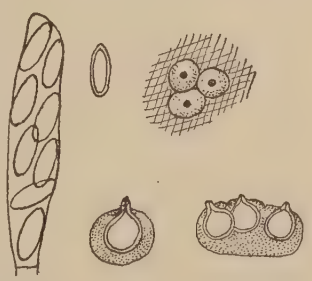

Fig. 31. *Selinia pulchra*; stroma seen from above, ×4; simple stroma in section, ×10; compound stroma in section, ×8; ascus and spores, ×200; ascospore, ×200.

Selinia pulchra (Wint.) Sacc., *Syll. Fung.* II (1883), 457; *Hypocreopsis pulchra* Winter in *Hedwigia* (1875), 26.

Stromata at first small, subglobose or irregular, partly or almost

entirely immersed, containing a single perithecium, generally coalescing later into a rusty red crust, covered by a dense rusty brown tomentum, the hyphae of which bear short, cylindrical conidia; perithecia immersed, globose, up to 0·7 mm. diameter, with a stout, truncated conical, projecting ostiolum, wall yellow, ostiolum dark red; asci oblongo-clavate, sometimes ventricose below and attenuated above, sessile, apex rounded or truncate, 130–200 × 40–48 μ, eight- or four-spored, spores biseriate or irregularly clustered; ascospores ellipsoid, obtuse or subacute, hyaline, continuous, thick-walled, 48–55 × 22–24 μ.

On sheep dung, Warleigh Common near Shrewsbury, October 1874 (Phillips and Plowright), Plowright, *Sphaer. Brit.* no. 100; on cow and sheep dung, Terrington St Clements, Norfolk, 1875 (Plowright); near King's Lynn, November–December, 1898 (Plowright).

HYPOCREOPSIS Karst., *Mycol. Fenn.* (1873), 251 and 281

Stroma superficial, effused, lobed, fleshy, bright-coloured; perithecia immersed; asci cylindrical, eight-spored; ascospores ellipsoid, hyaline, one-septate, not dividing.

Hypocreopsis lichenoides (Tode) Seaver in *Mycologia*, II (1910), 82; *Acrospermum lichenoides* Tode, *Fung. Meckl.* I (1790), 9; *Sphaeria riccioidea* Bolton, *Fung. Halifax*, IV (1791), 182; *Hypocrea riccioidea* (Bolt.) Berk., *Outlines* (1860), 383; *Hypocreopsis riccioidea* (Bolt.) Karst., *Myc. Fenn.* (1873), 251; Crossland in *Naturalist*, October 1908, 371, figs.

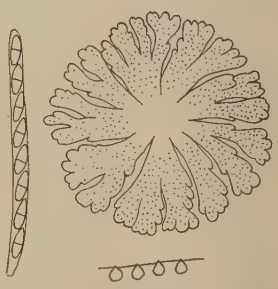

Fig. 32. *Hypocreopsis lichenoides*; stroma, × ⅔; perithecia (magnified); ascus and spores, × 200 (after Crossland).

Stroma branched, the branches radiating from a common centre and much divided, with irregularly lobed ends, up to 10 cm. across, closely adherent to the substratum, pale fulvous brown or somewhat orange, darkening towards the centre, minutely tuberculate, fleshy, internally whitish, 4–6 mm. thick; perithecia immersed, subglobose; asci cylindrical, 170–180 × 10 μ, eight-spored, spores obliquely uniseriate; ascospores hyaline, oblong-fusiform, smooth, 24–30 × 8–9 μ; paraphyses cylindrical, truncate above, about as long as the asci.

On dead branches of willow. Halifax (Bolton). Great Langdale, Westmoreland, May 1908 (Wheldon and Wilson), Hb. Kew. and Hb. B.M.; Corby Castle, Carlisle, 1883–6 (Dr Carlyle), Hb. Kew.; New Forest (Massee); Glamis, 1878 (Berkeley), Hb. Kew.; Dalry, Galloway, 9 September 1893 (J. McAndrew), Hb. B.M.

PODOSTROMA Karst. in *Hedwigia*, xxxi (1892), 294

Stroma stalked, clavate, erect, fleshy, light-coloured; perithecia immersed; asci cylindrical, eight,- then sixteen-spored; ascospores hyaline, at first ovoid, one-septate, then dividing into two globose, subglobose, or cuboid part-spores, hyaline or pale yellowish.

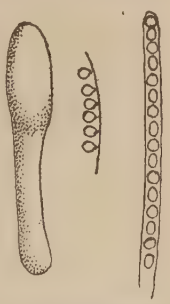

Fig. 33. *Podostroma alutaceum*; stroma, natural size; perithecia in section, × 6; ascus and spores, × 500.

Podostroma alutaceum (Pers.) Atkinson in *Bot. Gaz.* xl (1905), 416; *Sphaeria alutacea* Pers., *Comment. Fung. Clavaef.* (1797), 12; *Sphaeria clavata* Sowerby, *Eng. Fungi* (1799), pl. 159; *Hypocrea alutacea* (Pers.) Tul., *Sel. Fung. Carp.* i (1861), 62; *Podocrea alutacea* (Pers.) Lindau, *Engler-Prantl, Naturl. Pflanzenf.* i, 1 (1897), 364.

Stroma vertical, clavate, up to 4 cm. high, sometimes with a rooting base, pale yellow or whitish, sterile below, fertile above; perithecia immersed, globose, 0·2–0·25 mm. diameter, with a papillate ostiolum; asci cylindrical, pedicellate, 80–90 × 4 μ; part-spores globose, 4 μ diameter, or oval, 4–4·5 × 3 μ, hyaline, minutely warted.

On the ground in fir plantations, or on decaying stumps. Newmarket Heath (Rev. J. Hemsted); Costessy, Norfolk (Sowerby); Dinmore near Hereford, October 1874, Plowright, *Sphaer. Brit.* ii, no. 3; Lucknam, Wilts, September 1843, 1859 (Broome), Hb. B.M.; Swanage, 19 November 1857 (Broome), Hb. B.M.; near King's Lynn (Plowright); Westley, Suffolk (Bloomfield); Haslemere (B.M.S.), Hb. Kew.; Den of Fullerton (Rev. J. Ferguson); etc.

HYPOCREA Fries, *Syst. Orb. Veg.* (1825), 104

Stroma horizontal, fleshy, pulvinate or effused, usually with a definite margin, bright-coloured; perithecia immersed; asci cylindrical, eight-, then sixteen-spored; ascospores at first ovoid, one-septate, then dividing into two globose, subglobose, or cuboid part-spores, hyaline or pale yellowish.

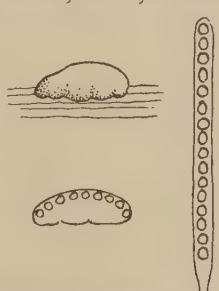

Fig. 34. *Hypocrea rufa*; stroma, × 6; vertical section of stroma, × 6; ascus and ascospores, × 500.

Hypocrea pulvinata Fuckel, *Symb. Mycol.* (1869), 185; *Hypocrea citrina* var. *fungicola* Karst., *Myc. Fenn.* ii (1873), 204.

Stromata at first white and tomentose, becoming pale yellow and glabrous, punctate with the depressed ostiola, finally pale brown or pallid, circular or oval in plan, up to 8 mm. diameter, or larger and irregular by confluence, pulvinate, even, sometimes tuberculate when old, attached over the whole base, up to 2 mm. thick when fresh, margin definite rounded; context very pale yellow, almost white, becoming brownish when old, fleshy, becoming

corky; perithecia crowded in a yellow peripheral layer, small, ovoid, 0·2 mm. high, 0·15 mm. diameter, wall yellow, then brownish; asci cylindrical, 80–90 × 3 μ; part-spores hyaline, smooth, broadly oval or rectangular, or somewhat wedge-shaped, 4–5 × 2·5–3 μ, sometimes globose, 3 μ diameter, extruded in white masses.

On decaying *Polypori*, especially *Polyporus betulinus*. Darnaway Forest, September 1879 (Phillips and Plowright). Helmsley; North Wootton; Plumstead (Norfolk); Ludlow. Specimens in Hb. Kew. from Inver, Perth, 1911; Worcester, 25 May 1912 (J. W. Ellis); Mickleham, 11 November 1923 (J. Harvey Bloom); Black Hills, North Wootton, 30 March 1930 (T. Petch). Also recorded from Drumnadrochit, Aviemore, Minehead, Petersfield, Haslemere, and Arundel (B.M.S.).

Hypocrea splendens Phil. & Plowr. in *Grevillea*, XIII (1885), 79.

Stromata golden yellow, then reddish orange, with a brown tinge when old, dotted with brown ostiola, pulvinate or two-thirds globose, 3–6 mm. diameter, scattered, or clustered and distorted by mutual pressure, even, or minutely tuberculate when dry, base flat, internally fleshy, yellowish white; perithecia crowded in an orange peripheral zone, globose, 0·18 mm. diameter, or vertically oval, 0·25 × 0·15 mm., wall hyaline; asci cylindrical, 80–90 × 4–5 μ, apex shortly capitate; part-spores cuboid, becoming globose, 4–5 μ diameter, or oval, 4·5–6 × 3·5–4 μ, hyaline, minutely warted.

On laurel sticks, Leicestershire, October 1881 (T. Howse), Hb. Kew.; Ken Wood, Hb. Kew., ex Hb. Cooke.

Hypocrea rufa (Pers.) Fr., *Summa Veg. Scand.* (1849), 383.

Stroma at first surrounded by a byssoid, white mycelium from which it separates, discoid, slightly convex, or pulvinate, 3–10 mm. diameter, sometimes confluent, at first chestnut-brown with a paler or white margin, becoming entirely chestnut-brown or rufous brown, opaque, faintly dotted with minute, subtranslucent ostiola, even, smooth, wrinkled when dry, fleshy, whitish internally, margin definite, rounded, sometimes incised or lobed, base flat; perithecia globose, about 0·2 mm. diameter, wall yellowish; asci cylindrical, sporiferous part, 60–75 × 4–5 μ; part-spores globose, 3·5–4·5 μ diameter, or oval, 5–6 × 3·5–4 μ, hyaline, minutely warted.

Conidial stage, *Trichoderma lignorum* (Tode) Harz, effused, green, powdery; conidiophores lateral on the hyphae, solitary or in whorls, fusoid, 10 μ high, 2 μ diameter, bearing a small cluster of conidia on the attenuated apex; conidia spherical, blackish green, minutely warted, 3–6 μ diameter.

On wood and bark; also on old fungi, *Polypori*, *Pezizae*, *Elaphomyces*, etc. Generally distributed.

Hypocrea Schweinitzii (Fr.) Sacc., *Syll. Fung.* II (1883), 522; *Sphaeria Schweinitzii* Fr., *Elenchus*, II (1828), 60; *Sphaeria rigens* Fr., *Elenchus*, II (1828), 61; *Sphaeria contorta* Schwein. in *Trans. Amer. Phil.*

Soc. II (1832), 194; *Hypocrea contorta* (Schwein.) B. & C. in *Grevillea*, IV (1875), 14; *Hypocrea rigens* (Fr.) Sacc. in *Michelia*, I (1878), 301; *Hypocrea lenta* Auctt., *non Sphaeria lenta* Tode.

Stromata up to 1 cm. diameter, lenticular, centrally attached, circular, margin free and sometimes lobed, often undulating, black with a greenish tinge, minutely verrucose with projecting ostiola when mature, internally white, the isolated cells of the cortex green when fresh, olive to blackish when old; perithecia immersed, globose, about 0·15 mm. diameter, wall hyaline to pale brown; asci cylindrical, 60–66 × 4 μ; part-spores equal, globose, hyaline, almost smooth, with a large central gutta, 3·5 μ diameter.

On dead wood. Wood Heath, Chislehurst, August 1855 (Currey), Hb. Kew.; St Catherine's, November 1866 (Broome), Hb. Kew. and Hb. B.M.; Foxley Woods, October 1875 (Plowright and Phillips), Hb. B.M.; near Reeth, October 1936 (W. G. Bramley); Brandon, November 1876 (Plowright).

Hypocrea argillacea Phil. & Plowr. in *Grevillea*, XIII (1885), 79.

At first lemon-yellow, opaque, with slightly darker ostiola, about 2·5 mm. diameter, pulvinate, convex, even, glabrous, margin rounded, becoming dull brown, finally, or when dried, collapsing and becoming pale brownish yellow or red-brown, flattened pulvinate, or thin and discoid, minutely tuberculate with perithecial elevations; perithecia crowded in a peripheral layer, globose, 0·1–0·15 mm. diameter, or vertically ovoid, 0·15 mm. high, 0·1 mm. diameter, wall yellow; internally white, friable; asci cylindrical, 80–90 × 3·5–4 μ; part-spores unequal, the lower usually the larger, hyaline, minutely warted, globose, 3–3·5 μ diameter, or ovoid, 4–4·5 × 3 μ.

The type specimen, on soft, rotten wood, Dersingham, November 1881, appears to have been lost. The above description has been drawn up from the following specimens. On a fallen branch of birch, North Wootton, November 1936; on dead wood, Lyndhurst (Massee) and Carlisle (Massee), both in Hb. B.M. as *Hypocrea farinosa*.

Hypocrea lutea Petch in *Journ. Bot.* LXXV (1937), 231; *Sphaeria gelatinosa* f. *lutea* Tode, *Fung. Meckl.* II (1791), 481.

At first white, circular, byssoid, plane, becoming fleshy, pulvinate or discoid, up to 2 mm. diameter, sometimes with a narrow byssoid margin, ochraceous when fresh (Hawley), red-brown when dry, sometimes subtranslucent above, minutely tuberculate with perithecial elevations; outer layer of the stroma and walls of the perithecia yellow-brown; internally white, friable, sometimes with a harder core at the base; perithecia globose or vertically ovoid; asci cylindrical, 90–100 × 5 μ; part-spores hyaline, minutely warted, unequal, globose, 4–4·5 μ diameter, or oval, 5 × 3·5–4·5 μ, sometimes 7 × 4 μ.

On dead leaves, Hurst Wood, October 1856 (Currey), Hb. Kew.; Tumby, Lincs, October 1905 (Hawley), Hb. B.M. The above description has been drawn up from the herbarium specimens. Currey at first considered his specimen a new species, but finally referred it to *Hypocrea gelatinosa*.

Hypocrea strobilina Phil. & Plowr. in *Grevillea*, XIII (1885), 79.

"Discoid, stroma whitish, thin, 1–4 mm. across; perithecia yellowish, rather large; asci cylindrical, octosporous; sporidia separating into two halves, each of which is subglobose, hyaline, 5–6 × 5–5·5 μ."

On cones of spruce, Belmont, Hereford, November 1878 (J. Renny). Also recorded from Osmotherley, Yorks, on decaying pine wood (Crossland). No specimens available.

Hypocrea citrina (Pers.) Fr., *Summa Veg. Scand.* (1849), 383; *Sphaeria citrina* Pers., *Obs. Myc.* I (1796), 68.

Stroma effused, often spreading for several inches over wood, earth, etc., flat, often irregularly undulating or tuberculate owing to irregularities in the substratum, usually with a white, byssoid margin, elsewhere fleshy, lemon-yellow, minutely tomentose and minutely verrucose with the papillate, darker ostiola, internally white, solid, sometimes fibrillose at the base, up to 0·5 mm. thick; perithecia immersed, crowded in a yellow superficial zone, globose, 0·25 mm. diameter, wall yellow to brownish yellow; asci cylindrical, 85–100 × 4–5 μ; part-spores unequal, the upper globose, 4 μ diameter, the lower oval or subrectangular or wedge-shaped, 5–7 × 3–4 μ, hyaline or pale yellow, minutely warted.

On dead wood, earth, etc. Generally distributed.

Hypocrea lactea Fr. is a white or pallid form of *H. citrina*, but the British specimens recorded under that name are misidentified.

Hypocrea placentula Grove in *Journ. Bot.* XXIII (1885), 133, pl. 256, fig. 5.

Stromata scattered, thin, at first with a byssoid margin, becoming compact with a definite rounded margin, discoid, suborbicular, 1–3 mm. diameter, flat, readily separable from the substratum, white, punctate with brownish ostiola; upper layer continuous, of crowded perithecia, internally loose; perithecia globose, 0·15 mm. diameter, almost completely immersed, wall pale yellow; asci cylindrical, 80–90 × 3–4 μ; part-spores almost equal, globose, hyaline, minutely warted, 2·5–3·5 μ diameter.

At the base of culms of *Juncus effusus*, Olton Reservoir, Warwickshire, September (Grove).

In some respects, the stroma resembles that of *Protocrea delicatula*, but the upper layer becomes continuous, and the perithecia do not project and are different in shape from those of the latter species.

CHROMOCREA Seaver in *Mycologia*, II (1910), 58

Stroma, asci and spores as in *Hypocrea*, but spores coloured, green or olivaceous.

Chromocrea gelatinosa (Tode) Seaver, *loc. cit.*; *Sphaeria gelatinosa* Tode, *Fung. Meckl.* II (1791), 48; *Hypocrea gelatinosa* (Tode) Fr.,

Summa Veg. Scand. (1849), 383; *Hypocrea moriformis* Cke & Massee, *Grevillea*, XVII (1888), 3.

Stromata pulvinate or hemispherical, 1–3 mm. diameter, often tuberculate, subgelatinous and subtranslucent when moist, the dark contents of the perithecia being visible, yellow or dark amber, becoming opaque and wrinkled when dry, internally pallid; perithecia immersed, crowded, vertically ovoid, up to 0·25 mm. high, 0·15 mm. diameter; asci cylindrical, 80–88 × 3·5–4·5 μ, eight- then sixteen-spored; part-spores unequal, the upper globose, 4 μ diameter, the lower oval or ellipsoid, 5–6 × 3–4 μ, coarsely warted, dark green when fresh, becoming olivaceous when dry.

On decaying wood. Generally distributed.

Chromocrea cupularis (Fr.) Petch, comb. nov.; *Sphaeria cupularis* Fr., in *Linnaea* (1830), 539; *Hypocrea cupularis* (Fr.) Sacc., *Syll. Fung.* II (1883), 535; *Hypocrea dacrymycella* Cooke & Plowr. in *Grevillea*, XII (1884), 100; *Hypocrea viscidula* Phil. & Plowr. in *Grevillea*, XIII (1885), 79.

Stromata at first globose, flattened above, then discoid, becoming cup-shaped, or ultimately pezizoid with an expanded or lobed margin, up to 10 mm. diameter, 5 mm. thick, pale yellow, externally viscid when fresh, but internally compact, whitish, becoming yellow; disc at first spotted with brown, then (when the spores are ripe) with green; perithecia confined to the disc, globose, 0·18 mm. diameter, or laterally oval, 0·18 × 0·12 mm., wall hyaline; asci cylindrical, capitate, 100–125 × 7–8 μ; ascospores dividing equally or unequally; part-spores oval or subquadrangular, 8–9 × 6–7 μ, or globose, 6–9 μ diameter, with a few undivided (?) spores, oval, 12–13 × 7 μ, dark green, becoming olivaceous, coarsely warted.

On coniferous logs. On *Pinus sylvestris*, Brandon, October 1881 (Plowright), Hb. Kew.

Chromocrea aureo-viridis (Plowr. & Cooke) Petch, comb. nov.; *Hypocrea aureo-viridis* Plowr. & Cooke in *Grevillea*, VIII (1880), 104.

Stromata scattered or clustered, at first pulvinate, becoming depressed in the centre and pezizoid, centrally attached, circular, up to 2·5 mm. diameter, the larger examples plicate, pale yellow, then orange, the disc becoming olive, when dry pale brown with darker, subtranslucent ostiola, internally pale yellowish; perithecia confined to the disc, immersed, crowded, small, globose, about 0·1 mm. diameter; asci cylindrical, 70–75 × 4 μ; part-spores equal, globose, 4 μ diameter, or slightly ovoid, 4·5 × 4 μ, dark green, coarsely warted.

On hazel. North Wootton, November 1879 (Plowright) Hb. Kew.

EPICHLOË Fries, *Summa Veg. Scand.* (1849), 381 (as subgenus).

Stroma superficial, sessile, effused, surrounding the stems of grasses, at first white and byssoid, then fleshy, bright-coloured; perithecia at first free, then confluent; asci cylindrical, very long, capitate; ascospores linear, almost as long as the ascus, multiseptate, not dividing into part-spores.

Epichloë typhina (Pers.) Tul. in *Ann. Sci. Nat.* ser. 4, XIII (1860), 18; *Sphaeria typhina* Pers., *Icon. et Descript.* I (1798), 21; *Sphaeria spiculifera* Sow., *Engl. Fungi* (1803), pl. 274; *Dothidea typhina* (Pers.) Fr., *Syst. Mycol.* II (1823), 553; *Stromatosphaeria typhina* Grev., *Scott. Crypt. Flora*, IV (1826), pl. 204; *Hypocrea typhina* (Pers.) Berk., *Outlines* (1860), 383. Conidial stage, *Sphacelia typhina* (Pers.) Sacc. in *Michelia*, II (1881), 297.

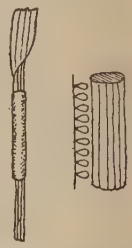

Fig. 35. *Epichloë typhina*; stroma on grass, ×½; stroma in longitudinalsection ×6.

Stroma sheathing the stems of grasses, up to 5 cm. long, at first white and bearing cylindrical or narrow-oval, hyaline conidia, 3–9 × 1–2 μ, on *Cephalosporium* conidiophores, becoming orange or golden yellow; perithecia crowded, at first free, becoming confluent, oval, 0·3–0·6 mm. high, 0·25 mm. diameter, apex obtuse; asci 6–8 μ diameter, eight-spored; ascospores linear, almost as long as the ascus, 1·5–2 μ diameter, septate at intervals of 8–12 μ.

On living grass stems, especially *Dactylis*, *Holcus*, *Phleum*, etc. Common.

OOMYCES B. & Br. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 185

Stroma erumpent, conoid, small, light-coloured, apex truncate, cortex membranous, tough, internally soft; perithecia few in each stroma, flask-shaped, vertical, opening on the truncate apex; asci narrow cylindrical, very long; ascospores linear, hyaline, multiseptate, not dividing into part-spores.

Oomyces carneo-albus (Libert) B. & Br., *loc. cit. supra*; *Sphaeria carneo-alba* Libert, *Crypt. Ard.* no. 241.

Stromata erumpent, scattered, pale flesh-coloured when fresh, becoming cream-coloured, matt, conical, 0·6–0·75 mm. high, 0·5 mm. diameter, contracted towards the apex, which is truncate, slightly convex, punctate with the mouths of the perithecia; perithecia three to seven in each stroma, immersed, narrow flask-

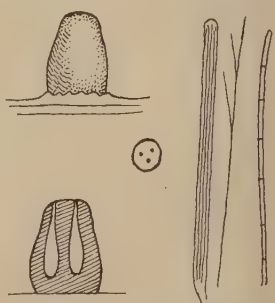

Fig. 36. *Oomyces carneo-albus*; stroma, ×20; vertical section of stroma, showing perithecia, ×20; apex of stroma, ×10; ascus, paraphysis and ascospore, ×500, but shortened.

shaped, vertical, up to 0·2 mm. diameter, almost as long as the height of the stroma, their apices fused with the wall of the stroma; asci 5–6 μ diameter, rather thick-walled, apex rounded, not capitate; paraphyses as long as the asci, 0·75 μ diameter, branched at the apex; ascospores linear, hyaline, multiseptate, 1·5 μ diameter, in a parallel bundle.

On dead leaves of *Aira caespitosa*. Spye Park, Wilts (Broome), Hb. Kew. and Hb. B.M.; Lyndhurst (Massee), Hb. B.M.; Batheaston, January 1851, March 1859, Hb. Kew.; Carlisle, June 1886 (Dr Carlyle), Hb. Kew.; near Perth, May 1912 (J. Menzies), Hb. Kew.

CORDYCEPS Link, *Handb.* III (1833), 347

Stroma (clava) erect, usually consisting of a terete stalk and a clavate, ovoid, or subglobose head, fleshy; perithecia immersed in the head (in British species), usually flask-shaped, sometimes with the ostiola projecting; asci cylindrical, very long, capitate; ascospores filiform, almost as long as the ascus, multiseptate, dividing into short, rod-like, or narrow-oval, part-spores in the ascus.

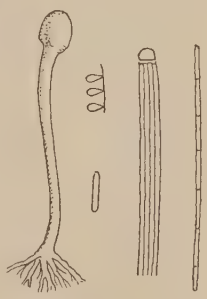

Fig. 37. *Cordyceps gracilis*; clava, natural size; perithecia in section, ×6; upper part of ascus and ascospore, ×1000; part-spore, ×1000.

Cordyceps ophioglossoides (Ehrh.) Link, *Handb.* III (1833), 347; *Sphaeria ophioglossoides* Ehrh., in Pers. *Holmsk. Coryph.* (1797), 144; *Sphaeria ophioglossoides* (Ehrh.) Fr., *Syst. Mycol.* II (1823), 324; *Clavaria parasitica* Willd., *Fl. Berol.* (1787), 405; *Cordyceps parasitica* (Willd.) Seaver in *North American Flora*, III (1910), 53.

Clava up to 10 cm. high, consisting of a comparatively slender stalk and an ovoid or oblong head very variable in size and shape, the whole fungus at first yellow or greenish yellow, becoming black; stalk smooth, 1–3 mm. diameter, terminating below in yellow mycelium; head usually laterally compressed, varying from narrow-oblong, 6 mm. high, 2 mm. broad, to broadly ovoid, 2·5 cm. high, 1·3 cm. broad, rounded above, smooth, then rough with projecting ostiola, becoming furrowed when old, internally loose and fuscous when dry; perithecia immersed, crowded, oval with a short neck, 0·7 mm. high, 0·36 mm. diameter; asci long, cylindrical, 7 μ diameter, eight-spored; part-spores hyaline, cylindrical with rounded ends, or oblong-oval, 2·5–5 × 2 μ, a few subglobose, 2·5 μ diameter, with many longer, non-septate fragments, 6–30 × 1·5–2 μ, often persisting in white masses on the mature fungus.

Parasitic on *Elaphomyces*. Generally distributed. Near Norwich (Berkeley, in *English Flora*, V, 233); Castle Rising (Plowright); North Wootton; Westwick.

Recorded from Whitby, Doncaster, Minehead, Keswick, Drumnadrochit, Forres, Bettwsycoed (B.M.S.); and Thirsk, Raincliff Wood, Scarborough, Blackwood near Selby, Mulgrave Woods, Burnsall (*Yorks. Nat. Union*).

Cordyceps capitata (Holms.) Link, *Handb.* III (1833), 347; *Clavaria capitata* Holms., *Topsv.* 38 (1790); *Sphaeria capitata* (Holms.) Fr., *Syst. Mycol.* II (1823), 324; *Sphaeria agariciformia* Bolt., *Fung. Halifax* (1789), 130; *Cordyceps agariciformia* (Bolt.) Seaver in *North American Flora*, III (1910), 53.

Clavae solitary or clustered, up to 9 cm. high, consisting of a stout stalk and an ovoid or subglobose head, sharply defined from the stalk; stalk up to 7·5 cm. high, 1 cm. diameter, equal or slightly attenuated upwards, terete, smooth, becoming longitudinally furrowed, sometimes furfuraceous and hollow when old, yellow, blackening when old; head up to 2 cm. high and in diameter, yellow-brown or chestnut-brown, becoming black, smooth when fresh, rough with projecting ostiola when dry; perithecia immersed, oval or oblong-oval with a short neck, 0·6–0·7 mm. high, 0·25 mm. diameter; asci long, cylindrical, eight-spored, about 15 μ diameter; part-spores hyaline, fusoid, narrow-oval, or subcylindrical, ends truncate and usually solid for a length up to 5 μ, thick-walled, 7–48 × 3–6 μ.

Parasitic on *Elaphomyces*. Generally distributed, but not common. Ramsden Wood, Halifax (Bolton); Holt, Norfolk (Berkeley in *English Flora*, V, 233); Haslemere and Bettwsycoed (B.M.S.); West Runton and Westwick, Norfolk; Inverary (Stevenson and Paul); Weybridge; Botley, Hants (Phillips and Plowright); New Forest, — Costicles, Ramnor, Denny (Rayner).

Cordyceps militaris (Linn.) Link, *Handb.* III (1833), 347; *Clavaria militaris* Linn., *Sp. Pl.* (1753), 1182; *Torrubia militaris* Tul., *Sel. Fung. Carp.* III (1865), 6.

Clava up to 5 cm. high (usually smaller), 5 mm. diameter above, clavate, red or orange-red, waxy; head narrow-oval, apex rounded, slightly rough with the subtranslucent ostiola; stalk of the same colour as the head or rather paler; perithecia at first immersed, becoming more or less superficial in old and weathered, or dried, specimens, oval, up to 0·5 mm. high, 0·3 mm. diameter; asci cylindrical, capitate, very long, 4 μ diameter, eight-spored; ascospores linear, as long as the ascus, dividing into short part-spores, which are at first cylindrical with truncate ends, becoming barrel-shaped or narrow-oval, 3·5–6 × 1–1·5 μ.

Conidial stage, *Cephalosporium* sp., occurring at the base of the perithecial clava and on the mycelium on the host; conidiophores simple, narrow flask-shaped or conical, up to 9 μ high, 1·5 μ diameter below, tapering to the apex; conidia hyaline, oval, or subpyriform with one end acute, 2·5–3 × 1·5–2 μ, sometimes globose, 1·5–2 μ diameter, with a few larger subpyriform with a truncate base, up to 6 × 3 μ.

On larvae and pupae of Lepidoptera. Generally distributed; usually occurring in the autumn.

Cordyceps gracilis Mont. & Dur. in *Flor. Alger*, I, 449, pl. 25, fig. 2 (1846–69); *Cordiceps entomorrhiza* Berk. *non* (Dicks.) Link, *Outlines* (1860), 382, pl. 23, fig. 5, and Cooke, *Vegetable Wasps, etc.* (1892), 164; *Cordyceps Mawleyi* Westwood in *Gard. Chron.* ser. 3, IX (1891), 553, fig. 115.

Clavae up to 4 cm. high, consisting of a stout, usually straight stalk, up to 3·3 cm. high, and an ovoid or subglobose head, up to 7 mm. high, 5 mm. diameter; stalk terete, about 2 mm. diameter, yellow, smooth, expanding suddenly into the head; head chestnut-brown, smooth, ostiola inconspicuous; perithecia immersed, flask-shaped, 0·6 mm. high, 0·25 mm. diameter; asci cylindrical, capitate, very long, 4–5 μ diameter; ascospores linear, as long as the ascus, dividing into cylindrical, truncate, part-spores, 5–9 × 1·5–2 μ.

Conidial stage, *Spicaria* (*Isaria*) *dubia* Delacr., in *Bull. Soc. Mycol. France*, IX (1893), 264, clavae numerous, slender, lax, decumbent or repent, up to 1 cm. long, 0·1 mm. diameter, white or yellowish, covered with diverging conidiophores; phialides in terminal or lateral clusters, flask-shaped, 7–10 × 2–2·5 μ; conidia hyaline, narrow fusoid, ends subacute, 4–6 × 1 μ.

On buried larvae of Lepidoptera, usually *Hepialus*. Frequent; sometimes occurring in numbers in gardens in the spring. This species has usually been recorded in this country as *Cordyceps entomorrhiza*.

Cordyceps entomorrhiza (Dicks.) Link, *Handb.* III (1833), 347; *Sphaeria entomorrhiza* Dickson, *Plant. Crypt. Brit.* I (1785), 22, pl. 3, fig. 3; *Xylaria entomorrhiza* (Dicks.) Gray, *Nat. Arrang. Brit. Plants*, I (1821), 511.

Clava up to 19 cm. high, consisting of a slender, flexuose stalk and a subglobose head; stalk at first brown below, ashy above, becoming black, smooth, sometimes forked, about 1 mm. diameter; head subglobose or ovoid, about 6 mm. diameter, violet-grey, becoming black, rough with the projecting ostiola; part-spores cylindrical, truncate, 6–8 × 1·5–2 μ (Tulasne).

On beetles and beetle larvae, usually *Carabus*. Found only once in this country, on a beetle larva, Bulstrode, Bucks, in the autumn (Dickson).

Cordyceps sphecocephala (Klotzsch) Cooke, *Vegetable Wasps, etc.* (1892), 40; *Sphaeria sphecocephala* Klotzsch in Hb. Hooker, Berkeley, *London Journ. Bot.* II (1843), 206.

Clava up to 6 cm. high, consisting of a slender stalk and a small ovoid or cylindrical head; stalk about 0·5 mm. diameter, usually flexuose and twisted, pale brown or brownish white, smooth, matt, longitudinally striate, the outer layer sometimes splitting away and recurving; head usually ovoid, acute above, up to 5 mm. high,

2–3 mm. diameter, sometimes cylindrical and up to 12 mm. long, yellow (? pale purple when fresh), dotted with subtranslucent ostiola, minutely vertically ridged when dry, with an ostiolum at the apex of each ridge; perithecia immersed, obliquely vertical, elongated flask-shaped or conoid, laterally compressed, 0·8 mm. high, 0·25 mm. broad; asci cylindrical, eight-spored, about $250 \times 8\,\mu$; part-spores narrow oval, $8–15 \times 1·5–2·5\,\mu$.

Conidial stage, *Hymenostilbe sphecophila* (Ditmar) Petch in *Trans. Brit. Mycol. Soc.* XXI (1937), 52; *Isaria sphecophila* Ditmar in *Sturm's Deutschl. Fl.*, Abt. III, Bd. I (1817), 115, pl. 57. Clava linear, up to 9 cm. high, 0·75 mm. diameter, tapering upwards, at first white or cream-coloured, then pale yellow or brownish yellow, straight or flexuose, terete, smooth, or very finely setulose in the upper part when magnified; basidia clavate or flask-shaped, $12–24 \times 4\,\mu$; conidia clavate, upper end rounded, lower end truncate, hyaline, smooth, $6–10 \times 4–5\,\mu$.

On Hymenoptera. ? On a wasp, Sluie, Rev. J. Keith, *Scottish Naturalist*, 1874; Specimen in Hb. B.M. ex Hb. Broome, from the Rev. G. Salmon, without locality or date. Conidial stage, Chopwell Wood, Northumberland, September 1933.

Cordyceps Forquignoni Quélet in *Compt. Rend. Assoc. Franc. Avanc. Sci.* (1887), 6, pl. 21, fig. 18; *Hypocrea myrmecophila* B. & Br. *non* Ces. in *Ann. Mag. Nat. Hist.* ser. 2, VII (1851), 186.

Clava up to 3·5 cm. high, consisting of a long, slender stalk and a small ovoid head; stalk irregularly curved, smooth, pale ochraceous, about 0·35 mm. diameter below, 0·5 mm. diameter above; head ovoid, 1·7 mm. long, 1 mm. diameter, orange; "asci cylindrical, $260–300 \times 5–6\,\mu$; part-spores fusiform, $11–12 \times 2\,\mu$" (Rea in *Trans. Brit. Mycol. Soc.* IV, 314).

Conidial stage, *Hymenostilbe muscaria* Petch in *Naturalist*, April 1931, 101. Clava linear, terete, equal, or laterally compressed above and bifurcate at the apex, up to 3 cm. high, brownish white, matt, white pruinose above; basidia subcylindrical or clavate, $12–25 \times 2·5–3·5\,\mu$, attenuated above, thick-walled, apex truncate or rounded, thickened, minutely verrucose, with one, or two, short, truncate sterigmata; conidia ovate, apex rounded, base obtuse or truncate, hyaline, smooth, $3–7 \times 1·5–3·5\,\mu$.

On flies. Leigh Wood, Somerset, May 1846, 1847 (Broome), Hb. B.M.; Trefriw, North Wales, May 1874 (Phillips), Hb. B.M.; Higher Greenwood, Hebden Bridge, 6 May 1893 (N. & P.), Hb. Kew.; Masham, 8 August 1902 (W. A. Thwaites), Hb. Kew.; Grassington, 16 September 1931 (F. A. Mason); Dolgelly, B.M.S. Spring Foray, 1913; Bettwsycoed, B.M.S. Foray 1924; Ludlow, B.M.S. Spring Foray, 1932. Conidial stage, Arncliffe Woods, Whitby; Malyan Spout, Goathland; Holt House Wood, King's Lynn; Bolton Woods, Yorks.

OPHIOCORDYCEPS Petch in *Trans. Brit. Mycol. Soc.* XVI (1931), 73

Stroma (clava) as in *Cordyceps*, but asci clavate, thick-walled at the apex, and ascospores hyaline, elongated fusoid, multiseptate, not dividing into part-spores.

Ophiocordyceps clavulata (Schw.) Petch in *Trans. Brit. Mycol. Soc.* XVIII (1933), 53; *Sphaeria clavulata* Schw., *Syn. N. A. F.* (1831), no. 1155; *Cordyceps clavulata* (Schw.) E. & E., *North American Pyreno.* (1892), 61, pl. 15; *Cordyceps pistillariaeformis* B. & Br. in *Ann. Mag. Nat. Hist.* ser. 3, VII (1861), 451, pl. 16, fig. 22.

Fig. 38. *Ophiocordyceps clavulata*; scale insect bearing a perithecial and a conidial clava, × 10; ascospore, × 500.

Clavae gregarious, about 2 mm. high, consisting of a straight, terete stalk and a broader, ovoid or cylindrical head, the whole white, ashy, or pale brown, fibrillose; stalk equal or slightly attenuated upwards, 0·2–0·4 mm. diameter; head 0·5–1·2 mm. high, 0·4–0·6 mm. diameter, rough with the black apices of the perithecia; perithecia immersed, narrow-oval, conoid above, 0·25 mm. high, 0·12 mm. diameter, wall brown, apex black; asci narrow clavate, 80–100 × 8–10 μ, eight-spored; ascospores narrow-clavate, seven- to eight-septate, 50–80 × 2 μ.

Conidial stage, *Hirsutella lecaniicola* (Jaap) Petch in *Trans. Brit. Mycol. Soc.* XVIII (1933), 53; *Isaria lecaniicola* Jaap in *Verh. Bot. Ver. Prov. Brandenburg* (1908), 49. Clavae white, ashy or pale brown, cylindrical or clavate, 2–4 mm. high, about 0·3 mm. diameter, apex obtuse; phialides crowded, base ovoid or conoid, 7–9 × 4–5 μ, with a stout sterigma, 5–7 μ long; conidia narrow-oval, oblong-oval, or clavate, 4–7 × 1·5–2 μ.

On scale insects, *Lecanium* spp. On a scale insect on wych elm, Batheaston, Somerset, March 1860, October 1860 (Broome), Hb. Kew. and Hb. B.M.

CLAVICEPS Tulasne in *Compt. Rend. Acad. Sci. Paris*, XXXIII (1851), 646

Stroma (clava) erect, arising from a sclerotium (ergot) and consisting of a thin, terete stalk and a globose head, bright-coloured, soft; perithecia immersed in the head, usually flask-shaped, sometimes with the ostiola projecting; asci cylindrical, very long, capitate; ascospores hyaline, linear, continuous in the ascus, but becoming septate on germination after extrusion.

Claviceps purpurea (Fr.) Tul. in *Ann. Sci. Nat.* ser. 3, XX (1853), 45, pls. 1, 2, 3, figs. 1–11; *Sphaeria purpurea* Fr., *Syst. Mycol.* II (1823), 325; *Cordiceps purpurea* Fr., Berkeley, *Outlines* (1860), 382; *Claviceps microcephala* (Wallr.) Tul. in *Ann. Sci. Nat.* ser. 3, XX (1853), 49;

Kentrosporium microcephalum Wallr. in *Beitr. Bot.* I (1844), 164; *Cordiceps microcephala* Tul., Berkeley, *Outlines* (1860), 382; ? *Sphaeria Hookeri* Kl., in Berkeley, *English Flora*, V (1836), 234. Conidial stage, *Sphacelia segetum* Lév. in *Mém. Soc. Linn.* V (1827), 578; *Farinaria Poae* Sow. pl. 396, f. 6. Ergot, *Spermoedia clavus* (DC.) Fr., *Syst. Mycol.* II (1822), 268; *Sclerotium Clavus* DC., *Fl. Franc.* VI (1815), 115.

Fig. 39. *Claviceps purpurea*; clavae on ergot, × 2; longitudinal section of the head, showing perithecia, × 8.

Conidial stage, white covering the ovary and adjacent structures; conidia ellipsoid, hyaline, 4–6 × 2–3 μ. Ergot, black, subcylindrical or fusoid, usually angular in section, straight or curved, sometimes longitudinally grooved, up to 2 cm. long, formed beneath the ovary, and pushing off the remains of the latter and the conidial stage. Perithecial clavae arising from the fallen ergot, and consisting of a long or short stalk and a subglobose head; stalk slender, straight or flexuose, purple, subtranslucent when fresh, smooth, socketed into the head; head depressed globose, cream-coloured, with brown ostiola, opaque, or purple and subtranslucent, even or tuberculate, the differences depending upon humidity during growth; perithecia immersed, flask-shaped, ostiola projecting slightly when dry; asci cylindrical, capitate, very long, about 5 μ diameter, eight-spored; ascospores long, linear, 0·75–1 μ diameter, continuous.

On the inflorescence of various grasses. Common. Several biologic forms occur.

Claviceps nigricans Tul. in *Ann. Sci. Nat.* ser. 3, XX (1853), 51, pl. 4, figs. 15–22.

Ergot linear, semicylindrical, obtuse, often strongly curved, black, up to 12 mm. long. Perithecial clava up to 8 mm. high, entirely blackish violet, head at first paler; head depressed globose, minutely verrucose; perithecia flask-shaped, ostiola slightly projecting; asci very long, cylindrical, capitate, eight-spored; ascospores linear, continuous, hyaline.

On *Scirpus* spp. Only the ergot has been observed in this country. On *Heleocharis palustris*, Hengistbury Head, and on ? *Heleocharis uniglumis*, Poole Heath, Dorset, August 1863 (H. Trimen), Hb. Kew.; on *Heleocharis palustris*, Clatto Reservoir, Fife, October 1909 (G. West), Hb. Kew.

Rejected names

Broomella leptogicola Cke & Massee is the fructification of a lichen.
Broomella Vitalbae B. & Br. belongs to the Sphaeriaceae.
Calonectria Leightonii (B. & Br.) Sacc. (*Nectria Leightonii* B. & Br.) is a lichen.

Melanospora discospora Massee & Salmon is probably *Chaetomium murorum* Cda.
Melanospora gigantea Massee & Crossland is *nomen nudum*.
Melanospora vitrea (Cda) Sacc. is *Sphaeronaemella*.
Nectria caulina Cke is *Ditopella Vizeana* Sacc. & Speg. (Sphaeriaceae).
Nectria umbrina (Berk.) Fr. belongs to the Sphaeriaceae.

Species described as new in this paper

Calonectria tessellata Petch, n.sp.

Peritheciis superficialibus, sparsis vel gregariis, udo sordide aurantiacis, sicco brunneo-flavis, conicis vel ovoideis, ad 0·3 mm. alt., 0·25 mm. diam., interdum medio collapsis, minute rugosis, glabris vel apice leniter verrucosis, ostiolo nudo, obscuriori; pariete externe cellularum magnarum composito; ascis clavatis, octosporis, sessilibus, apice truncato, 75–95 × 12–18 μ, sporis oblique uniseriatis vel biseriatis; ascosporis hyalinis, triseptatis, ovalibus vel oblongo-ovalibus, interdum inaequilateralibus, rectis, obtusis, 18–26 × 7–9 μ.

On decaying stalks of *Brassica*, North Wootton, Norfolk, November 1935; on dead apple twig, Camberley, November 1920, Hb. B.M.

Gliocladium strictum Petch, n.sp.

Conidiophoris congestis, albis, circa 100 μ alt., stipite basi 4 μ diam., ramulis paucis; ramulis inferioribus saepius solitariis, distantibus, superioribus (phialidibus) oppositis vel tri-verticillatis, circa 30 μ longis, attenuatis, ramulis omnibus erectis, parallelis; conidiis hyalinis, oblongo-ovalibus vel angusto-ovalibus, leniter inaequilateralibus, obtusis, 5–11 × 2–2·5 μ, longioribus ultimo uniseptatis vel pseudo-uniseptatis, muco conglutinatis.

On *Fomes annosus*; the conidial stage of *Hypomyces Broomeanus*.

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LIST OF MEMBERS

Correct to 12th May, 1938.

Honorary Members

Lister, Miss Gulielma, F.L.S., 871 High Road, Leytonstone, Essex. (1903.) (1924.)

Rea, Mr Carleton, B.C.L., M.A., 6 Barbourne Terrace, Worcester. (1896.) (1918.)

Ordinary Members

1. Aberdeen, The University Library. (1916.)
2. Adams, Rev. J. H., Landulph Rectory, Hatt, Saltash, Cornwall. (1919.)
3. Adcock, Mr Archie, Upton Road, Norwich. (1921.)
4. Ainsworth, Mr G. C., B.Sc., Ph.D., Experimental and Research Station, Cheshunt, Herts. (1931.)
5. Alaily, Mr Y. A. S. El, The Botany School, Cambridge. (1935.)
6. Alberta, University of Edmonton, Alberta, Canada. (1924.)
7. Alcock, Mrs N. L., F.L.S., M.B.E., 12 Tavistock Square, London, W. 1. (1919.)
8. Ashby, Mr S. F., B.Sc., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1926.)
9. Bacon, Mrs. Alice, B.Sc., F.L.S., Technical College, Brighton, Sussex. (1938.)
10. Barnes, Mr B., D.Sc., Ph.D., V.-P.L.S., Chelsea Polytechnic, London, S.W. 3. (1922.)
11. Barr, Rev. Robert, T.D., M.A., The Manse, Neilston, Renfrewshire. (1918.)
12. Barrington, Dr F. J. F., University College Hospital, Medical School, University Street, London, W.C. 1. (1901.)
13. Bartlett, Mr A. W., M.A., M.Sc., F.L.S., Department of Botany, King's College, Newcastle-on-Tyne. (1920.)
14. Bates, Mr G. R., c/o British South Africa Company, Mazoe Citrus Estate, Mazoe, S. Rhodesia. (1930.)
15. Bates, Mrs L. F., B.Sc.,
16. Beardslee, Mr H. C., Perry, Ohio, U.S.A. (1933.)
17. Beaumont, Mr Albert, M.A., Seale-Hayne Agricultural College, Newton Abbot, Devon. (1924.)
18. Bewley, Mr W. F., D.Sc., Experimental and Research Station, Cheshunt, Herts. (1922.)
19. Biffen, Professor Sir Rowland H., M.A., F.R.S., 136 Huntingdon Road, Cambridge. (1899.)

20. Biggs, Miss R., B.Sc., Ph.D., 26*b* Newton Road, London, W. 2. (1937.)
21. Biologist, Plant Research Laboratory, Horticultural Gardens, Burnley, Victoria, Australia. (1921.)
22. Birmingham Natural History and Philosophical Society, c/o Mrs O. W. Thompson, 18 Hermitage Road, Edgbaston, Birmingham. (1920.)
23. Bisby, Mr Guy R., Ph.D., Imperial Mycological Institute, Ferry Lane, Kew, Surrey.
24. Blackman, Professor V. H., M.A., F.R.S., F.L.S., 17 Berkeley Place, Wimbledon, London, W. 19. (1900.)
25. Blackwell, Miss E. M., M.Sc., F.L.S., Botanical Department, Royal Holloway College, Englefield Green, Surrey. (1917.)
26. Blumer, Dr S., Myrtenweg 12, Bern-Bumpliz, Switzerland. (1936.)
27. Bonn, Germany, Institut für Pflanzenkrankheiten, Nuss-Allee 9. (1931.)
28. Boston, The Mycological Club, Horticultural Hall, Boston, Mass, U.S.A. (1926.)
29. Bourgin, Dr Viennot, École Nationale d'Agriculture de Grignon, Seine-et-Oise, France. (1936.)
30. Braid, Professor K. W., B.A., B.Sc., West of Scotland Agricultural College, 6 Blythswood Square, Glasgow. (1922.)
31. Brazier, Mr E., Ty'n-y-gongl, Love Lane, Stourbridge. (1921.)
32. Brenchley, Mr G. H., B.A., Clare College, Cambridge. (1925.)
33. Brett, Miss M., M.Sc., Ph.D., Northern Polytechnic, Holloway Road, London, N. 7. (1921.)
34. Brierley, Professor W. B., D.Sc., F.R.A.I., F.L.S., Department of Agricultural Botany, The University, Reading. (1919.)
35. Brinton, Mr R. E. B., 68 Woodstock Avenue, Golders Green, London, N.W. 11. (1935.)
36. Brisbane, The Director, Bureau of Sugar Experiment Stations, Department of Agriculture and Stock, Queensland, Australia. (1930.)
37. British Museum, The Trustees of, Cromwell Road, South Kensington, London, S.W. 7. (1914.)
38. Brooks, Professor F. T., M.A., F.R.S., F.L.S., The Botany School, Cambridge. (1907.)
39. Brown, Dr Mabel Raven, Newnham College, Cambridge. (1936.)
40. Brown University, Library, East side Station, Providence, R.I., U.S.A. (1920.)
41. Brown, Professor W., M.A., D.Sc., F.R.S., Imperial College of Science, South Kensington, London, S.W. 7. (1922.)
42. Bruxelles, Jardin Botanique de l'État, c/o M. P. van Aerdschot. (1911.)

43. Buckley, Mr W. D., "St Anthony", Leigh Park, Datchet, Bucks. (1916.)
44. Buddin, Mr Walter, M.A., Laboratory of Plant Pathology, University of Reading, 7 Redlands Road, Reading. (1921.)
45. Buller, Professor A. H. R., D.Sc., Ph.D., F.R.S., c/o Herbarium, Royal Botanic Gardens, Kew. (1911.)
46. Bunting, Mr R. H., F.L.S., 3 Stanton Court, Weymouth. (1921.)
47. Burges, Mr N. A., The Botany School, Cambridge. (1935.)
48. Burr, Mr S., M.Sc., Department of Agriculture, The University, Leeds. (1924.)
49. Butler, Mr E. J., C.I.E., C.M.G., D.Sc., M.B., F.R.S., F.L.S., Agricultural Research Council, 6A Dean's Yard, London, S.W. 1. (1920.)
50. Caldwell, Mr J., D.Sc., Ph.D., Department of Botany, University College, Exeter. (1932.)
51. Cambridge, The Botany School. (1920.)
52. Campbell, Mr A. H., B.Sc., Ph.D., Department of Botany, The University, Bristol. (1934.)
53. Carne, Mr W. M., F.L.S., The University of Tasmania, Hobart, Tasmania, Australia. (1928.)
54. Carr, Professor J. W., M.A., F.L.S., Mapperley Edge, Private Road, Sherwood, Nottingham. (1896.)
55. Carrothers, Mr E. N., 7 Fitzwilliam Street, Belfast, N. Ireland. (1925.)
56. Cartwright, Mr K. St G., M.A., F.L.S., The Red House, Kingston Blount, Oxford. (1913.)
57. Castellani, Sir Aldo, M.D., 23 Harley Street, London, W. 1. (1922.)
58. Cayley, Miss Dorothy M., John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W. 19. (1913.)
59. Charles, Miss Vera K., United States Department of Agriculture, Bureau of Plant Industry, Washington D.C., U.S.A. (1933.)
60. Chaudhuri, Mr H., M.Sc., Ph.D., University of the Punjab, Lahore, India. (1920.)
61. Cheal, Mr W. F., Savile House, Queen's Road, Wisbech, Cambs. (1927.)
62. Chesters, Mr C. G. C., B.Sc., M.Sc., Ph.D., Botanical Department, The University, Edgbaston, Birmingham. (1930.)
63. Ciferri, Professor Dr R., Assistant Director, Laboratorio Crittogamico, Casella Postale 165, Pavia, Italy. (1926.)
64. Clapham, Mr A. R., M.A., Ph.D., Department of Botany, The University, Oxford. (1931.)
65. Cleland, Mr J. Burton, M.D., Professor of Pathology, University of Adelaide, South Australia. (1918.)

66. Clouston, Mr D., M.A., B.Sc., (Agr.), North of Scotland College of Agriculture, Crown Mansions, 41 Union Street (2nd Floor), Aberdeen. (1931.)
67. Colson, Miss B., B.Sc., Ph.D., The University, Manchester. (1934.)
68. Connecticut Agricultural Experiment Station, New Haven, Connecticut, U.S.A. (1929.)
69. Cook, Mr W. R. I., B.Sc., Ph.D., Department of Botany, University College, Newport Road, Cardiff. (1924.)
70. Cooke, Mr G. J., 143 Newmarket Road, Norwich. (1933.)
71. Cooke, Mrs G. J., 143 Newmarket Road, Norwich. (1937.)
72. Cooper, Miss Charlotte A., California Lane, Bushey Heath, Herts. (1911.)
73. Cooper, Mrs V. Astley, The Tors, Knowle, Fareham, Hants. (1921.)
74. Cornell University, The Library, New York State College of Agriculture, Ithaca, N.Y., U.S.A. (1920.)
75. Corner, Mr E. J. H., M.A., F.L.S., Assistant Director, Botanic Gardens, Singapore, Straits Settlements. (1924.)
76. Cotton, Mr Arthur D., O.B.E., F.L.S., Keeper, Herbarium, Royal Botanic Gardens, Kew, Surrey. (1902.)
77. Croxall, Mr H. E., B.Sc., Research Station, Long Ashton, Bristol. (1937.)
78. Cunningham, Mr G. H., Ph.D., Plant Research Station, Box 442, Palmerston North, New Zealand. (1922.)
79. Curtis, Miss Kathleen M., M.A., D.Sc., D.I.C., F.L.S., Mycologist, Biological Department, Cawthron Institute of Scientific Research, Nelson, New Zealand. (1917.)
80. Cutting, Mr E. M., M.A., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1920.)
81. Dade, Mr H. A., A.R.C.S., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1927.)
82. Das, Mr Kedarnath, C.I.E., M.D., Principal, Carmichael Medical College, 1 Belgachia Road, Calcutta, India. (1922.)
83. Davies, Mr D. W., B.Sc., Adviser in Mycology, Agricultural Buildings, University College of Wales, Aberystwyth. (1923.)
84. Davies, Mr D. L. Godfrey, Research Station, Long Ashton, Bristol. (1938.)
85. Day, Mr W. R., B.A., B.Sc., Imperial Forestry Institute, Oxford. (1928.)
86. Deacon, Dr G. E., Brundall, Norwich. (1933.)
87. Dehra Dun, The Forest Botanist, Forest Research Institute and College, U.P., India. (1929.)

88. Deighton, Mr F. C., M.A., Mycologist, Department of Lands and Forests, Freetown, Sierra Leone, West Africa. (1925.)
89. Delhi, Imperial Mycologist, Imperial Agricultural Research Institute, Delhi, India. (1921.)
90. Dennis, Mr R. W. G., Ph.D., School of Agriculture, Cambridge. (1932.)
91. Dickinson, Mr S., Ph.D., School of Agriculture, Cambridge. (1921.)
92. Dobbs, Mr C. G., B.Sc., Ph.D., Botanical Department, King's College, Strand, London, W.C. 2. (1933.)
93. Dodge, Dr Carroll W., Missouri Botanical Garden, 2315 Tower Grove Avenue, St Louis, Missouri, U.S.A. (1926.)
94. Dowson, Mr W. J., M.A., D.Sc., The Botany School, Cambridge (1920.)
95. Duff, Mr R. G., Perly Cross, Teignmouth, Devon. (1938.)
96. Duncan, Mr J. T., London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C. 1. (1930.)
97. Dunston, Capt. Ambrose E. A., Burltons, Donhead St. Mary, Wiltshire (via Shaftesbury). (1937.)
98. Edwards, Mr W. H., Belle Vue, Barline, Beer, Devon. (1896.)
99. Elliott, Mrs J. S. Bayliss, D.Sc. (B'ham.), B.Sc., (London), Arden Grange, Tanworth-in-Arden, Warwickshire. (1911)
100. Ellis, Mr E. A., Castle Museum, Norwich. (1937.)
101. Ellis, Mr E. H., B.Sc., Gramarye, Farley Green, Guildford, Surrey. (1936.)
102. Ellis, Miss E. M., B.A., B.Sc., St Hugh's College, Oxford. (1930.)
103. Ellis, Mr Holmes, F.R.M.S., 108 Birtwistle Avenue, Colne, Lancs. (1927.)
104. Emerson, Mr R., The Botany School, Cambridge. (1938.)
105. Emoto, Dr Y., Biological Department, Peers' College (Gakushuin), Mejiromachi, Tokyo, Japan. (1929.)
106. Essex Field Club, c/o Mr Percy Thompson, F.L.S., Essex Museum of Natural History, Romford Road, Stratford, London, E. 15. (1919.)
107. Exeter, Librarian, University College of the South-West of England. (1926.)
108. Eyre, Miss J. C., c/o Miss Wakefield, Herbarium, Royal Botanic Gardens, Kew. (1915.)
109. Fenton, Mr E. W., M.A., B.Sc., F.L.S., Biology Department, Edinburgh and East of Scotland College of Agriculture, Edinburgh. (1920.)
110. Findlay, Mr W. P., B.Sc., A.R.C.S., Courte Falaise, Sevenoaks, Kent. (1928.)
111. Finlayson, Mr Raymond A., F.L.S., Official Seed Testing Station, Huntingdon Road, Cambridge. (1910.)

112. Fisher, Mr S. D. P., Sackville Street, Leeds. (1930.)
113. Fitzpatrick, Professor H. M., Ph.D., 220 Bryant Avenue, Ithaca, New York, U.S.A. (1935.)
114. Fountain, Mr A. S., F.R.M.S., "Thornham" Fulwood Road, Sheffield, Yorks. (1934.)
115. Fraser, Miss Lilian R., D.Sc., Bank of New South Wales, Threadneedle Street, London. (1938.)
116. Gadd, Mr C. H., D.Sc., Tea Research Institute, Nuwara Eliya, Ceylon. (1921.)
117. Galloway, Mr L. D., 31 Lake Close, Wimbledon, London, S.W. 19. (1928.)
118. Gardner, Capt. Frederic, c/o Barclays Bank, Jersey, C.I. (1898.)
119. Garrett, Mr S. D., Rothamsted Experimental Station, Harpenden, Herts. (1936.)
120. Garside, Mr S., M.Sc., F.L.S., Botanical Department, Bedford College, Regent's Park, London, N.W. 1. (1922.)
121. Gates, Professor R. R., D.Sc., Ph.D., F.R.S., F.L.S., King's College Strand, London, W.C. 2. (1921.)
122. Ghamrawy, Mr Ali K., 39 Monirah Street, Cairo, Egypt. (1932.)
123. Gibson, Miss C. J., B.A., 27 Banbury Road, Oxford. (1933.)
124. Gilbert, Dr E. M., Botanical Department, University of Wisconsin, Madison, Wis., U.S.A. (1922.)
125. Gilbert, M. E., Docteur en Pharmacie, 6 Rue de Laos, Paris (15^{e}), France. (1924.)
126. Gill, Mr G. E., LL.B., 68 Pembroke Road, Dublin, Irish Free State. (1937.)
127. Gillespie, Mr J., B.Sc., Botany Dept., University of Reading, (1938.)
128. Glasstone, Mrs V. F. C., B.A. (Oxon.), 15 Northumberland Road, Sheffield. (1930.)
129. Glynne, Miss Mary D., M.Sc., F.L.S., Rothamsted Experimental Station, Harpenden, Herts. (1932.)
130. Gorman, Mr M. J., A.C.C.Sc.I., Albert Agricultural College, Glasnevin, Dublin. (1925.)
131. Gould, Mr F. G., Woodrising, Trapps Hill, Loughton, Essex. (1918.)
132. Green, Col. C. Theodore, A.M.S., M.R.C.S., L.R.C.P., F.L.S., 31 Shrewsbury Road, Birkenhead. (1901.)
133. Green, Miss F. Mary, M.A., Ph.D., 63 Canford Road, Clapham Common, London, S.W. 11. (1931.)
134. Gregor, Mrs M. J. F., Ph.D., Royal Botanic Garden, Edinburgh. (1927.)
135. Gregory, Mr P. H., Ph.D., Seale Hayne Agricultural College, Newton Abbot, Devon. (1930.)

136. Grieve, Mr B. J., M.Sc., Botanical Department, Melbourne University, Carlton, Victoria, Australia. (1931.)
137. Grinling, Mr C. H., B.A., 71 Rectory Place, Woolwich. (1913.)
138. Gwynne-Vaughan, Professor Dame Helen, G.B.E., D.Sc., LL.D., F.L.S., 93 Bedford Court Mansions, London, W.C. 1. (1906.)
139. Halley, Miss E. M., The Botany School, Cambridge. (1937.)
140. Hanna, Mr W. F., M.Sc., Dominion Rust Research Laboratory, Agricultural College, Winnipeg, Canada. (1925.)
141. Hansford, Mr C. G., M.A., F.L.S., Mycologist, Department of Agriculture, Kampala, Uganda. (1921.)
142. Harley, Mr J. L., M.A., D.Phil., Shrublands, Hethersett, Norfolk. (1932.)
143. Harris, Mr G. C. M., 148 Divinity Road, Oxford. (1934.)
144. Harris, Mr R. V., B.Sc., A.R.C.S., Horticultural Research Station, East Malling, Kent. (1924.)
145. Harrison, Mr T. H., D.Sc., Australia House, Strand, London, W.C. 2. (1931.)
146. Harvard University, The Library, Cambridge, Mass., U.S.A. (1923.)
147. Hastings, Mr Somerville, M.S., F.R.C.S., 43 Devonshire Street, Portland Place, London, W. 1. (1913.)
148. Hawker, Miss L. E., Ph.D., Botanical Department, Imperial College of Science, London, S.W. 7. (1934.)
149. Heim, M. Roger, Sous-Directeur au Muséum d'Histoire Naturelle, 11 Rue de Médicis, Paris (6^{e}), France. (1930.).
150. Heimbeck, Mrs Louise, Brosoe, Levanger, Norway. (1923.)
151. Hemmi, Dr Takewo, Phytopathological Institute, Department of Agriculture, Kyoto Imperial University, Kyoto, Japan. (1923.)
152. Hereford, Mr E. H., 131 Queen Victoria Street, London, E.C. 4 (1933.)
153. Hickman, Mr C. J., c/o Plant Pathology Lab., Milton Rd., Harpenden, Herts. (1935.)
154. Hildyard, Mr F. W., 1 Lichfield Road, Kew, Surrey. (1913.)
155. Holden, Professor H. S., D.Sc., F.R.S.E., F.L.S., Forensic Science Laboratory, Burton Street, Nottingham. (1923.)
156. Honolulu, Association of Hawaiian Pineapple Canners, P.O. Box 3166, Hawaii. (1929.)
157. Honolulu, The Library, Experimental Station, S.P.A., Box 411, Hawaii. (1920.)
158. Hopkins, Mr J. C. F., D.Sc., A.I.C.T.A., P.B., 74B Salisbury, S. Rhodesia. (1930.)
159. Horne, Mr A. S., D.Sc., F.L.S., F.G.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1921.)

160. Howard, Mr H. J., F.R.M.S., F.L.S., "Lingfield", 6 College Road, Norwich. (1918.)
161. Hubbard, Miss M. D., B.Sc., Laren, Western Drive, Littleover, Derby. (1933.)
162. Hughes, Mr G. C., Priory Road, Bicester. (1898.)
163. Hughes, Mr J. S., M.A., University Observatory, Oxford. (1927.)
164. Hull, The Librarian, Botanical Department, University College. (1929.)
165. Humphrey, Dr C. J., United States Department of Agriculture, Soil Conservation Service, Stafford, Arizona, U.S.A. (1921.)
166. Hurst, Mr C. P., F.L.S., Landulph Rectory, Saltash, Cornwall. (1928.)
167. Ingold, Mr C. T., M.Sc., Ph.D., Department of Botany, University College, Leicester. (1935.)
168. Iowa, The Library, State University of Iowa, Library Annex, Iowa City, U.S.A. (1923.)
169. Iowa State College, Library, Ames, Iowa, U.S.A. (1927.)
170. Issatchenko, Professor B. L., Directeur du Jardin Botanique, Leningrad, Russia. (1923.)
171. John Crerar Library, 86 East Randolph Street, Chicago, Illinois, U.S.A. (1929.)
172. John Innes Horticultural Institution, Mostyn Road, Merton Park, London, S.W. 19. (1924.)
173. Johnson, Mr J. W. Haigh, M.Sc., F.I.C., F.L.S., Walton, nr. Wakefield. (1919.)
174. Jones, Mr G. H., M.A., Plant Protection Section, Ministry of Agriculture, Cairo, Egypt. (1922.)
175. Jørstad, Mr Ivar, Statsmykolog, Botanisk Museum, Oslo, Norway. (1923.)
176. Keay, Miss M. A., M.A., (Cape Town), Department of Agricultural Botany, The University, Reading. (1935.)
177. Keene, Miss K. N., B.Sc., West of Scotland Agricultural College, Blytshwood Square, Glasgow. (1937.)
178. Keissler, Dr Karl, Direktor d. Botanischen Abteilung, Naturhistorisches Museum, Burgring 7, Wein 1/1, Austria. (1924.)
179. Kelly, Dr Howard A., 1418 Eutaw Place, Baltimore, Md., U.S.A. (1921.)
180. King, Miss M. E., B.A., The Botany School, Cambridge. (1935.)
181. Klika, Mr Bohumil, Hálkova, 37 Prague, Vrsovice 553 Czechoslovakia. (1926.)
182. Knight, Mr H. H., M.A., The Lodge, All Saints' Villas, Cheltenham. (1914.)

183. Kuala Lumpur, F.M.S., The Director of Agriculture, Straits Settlements, and Federated Malay States. (1930.)
184. Lamb, Mr I. M., British Museum (Natural History) London, S.W. 7. (1934.)
185. Lampitt, Mr L. H., D.Sc., F.I.C., Thornlea, Mount Park, Harrow, Middlesex. (1925.)
186. Leach, Mr R., B.A., Agricultural Department, Mlanje, Nyasaland. (1929.)
187. Leicester, The Museum, City of Leicester. (1923.)
188. Librarian, King's College, Newcastle-on-Tyne. (1928.)
189. Likhite, Dr Y. N., Department of Agriculture, Baroda State, India. (1936.)
190. Linder, Dr D., Farlow Herbarium, Harvard University, 20 Divinity Avenue, Cambridge, Mass., U.S.A. (1935.)
191. Line, Mr James, M.A., School of Agriculture, Cambridge. (1921.)
192. Linnean Society, The, Burlington House, Piccadilly, London, W. 1. (1919.)
193. Lloyd Library, The, 309 West Court Street, Cincinnati, Ohio, U.S.A. (1907.)
194. Loader, Miss F. M., B.Sc., Botanical Department, University College, Southampton. (1927.)
195. Lowndes, Mr A. G., M.A., F.L.S., Marlborough College, Marlborough, Wilts. (1922.)
196. Lütjeharms, Mr W. J., Department of Botany, University College of Orange Free State, Bloemfontein, S. Africa. (1930.)
197. McDonald, Mr J., D.F.C., B.Sc., F.L.S., Senior Plant Pathologist, P.O. Box 338 Nairobi, Kenya Colony, East Africa. (1923.)
198. McLennan, Dr Ethel I., Botanical Department, Melbourne University, Carlton, Victoria, Australia. (1926.)
199. Madras University Library, Senate House, Triplicane, Madras, South India. (1925.)
200. Maire, M. René, D.Sc., F.M.L.S., Professeur à la Faculté des Sciences de l'Université, Algiers, Algeria, N. Africa. (1907.)
201. Marsh, Mr R. W., M.A., Research Station, Long Ashton, Bristol. (1923.)
202. Masefield, Mr G. B., c/o Department of Agriculture, Entebbe, Uganda. (1932.)
203. Mason, Mr E. W., M.A., M.Sc., F.L.S., Imperial Mycological Institute, Ferry Lane, Kew, Surrey. (1921.)
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205. Matthews, Professor J. R., M.A., F.L.S., Department of Botany, The University, Old Aberdeen. (1921.)
206. Mathias, Mr W. T., B.Sc., The University, Liverpool. (1938).
207. Mehta, Professor K. C., Ph.D., Department of Biology, Agra College, Agra, U.P., India. (1921.)
208. Melville, Mr R., B.Sc., Ph.D., 5 Courtway, Twickenham, Middlesex. (1933.)
209. Metcalfe, Mr C. R., B.A., Ph.D., Jodrell Laboratory, Royal Botanic Gardens, Kew, Surrey. (1926.)
210. Michigan Agricultural College Library, East Lansing, Michigan, U.S.A. (1924.)
211. Miller, Professor J. H., B.S., M.S., Ph.D., University of Georgia, Athens, Ga., U.S.A. (1930.)
212. Millidge, Mr P. H., 205 Carisbrooke Road, Newport, I.O.W. (1937.)
213. Missouri, The Botanical Garden, St Louis, Mo., U.S.A. (1902.)
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215. Miyabe, Dr Kingo, Professor Emeritus of Botany, Hokkaido Imperial University, Sapporo, Japan. (1919.)
216. Montague, Mrs A., Penton, Crediton, N. Devon. (1898.)
217. Montreal, Canada, Faculté des Sciences, Institut Botanique, Université de Montréal. (1932.)
218. Moore, Mr W. C., M.A., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1922.)
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220. Morris, Mr L. E., c/o Eton College, Windsor, Berks. (1924.)
221. Muller, Dr H. R. A., Institut voor Plantenziekten, Buitenzorg, Java. (1932.)
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223. Murray, Mr G. H., F.E.S., Director of Agriculture, Rabaul, New Britain, Territory of New Guinea, via Australia. (1921.)
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225. Nannfeldt, Dr J. A., Sturegatan 11, Uppsala, Sweden. (1932.)
226. National Collection of Type Cultures, Curator, Lister Institute, Chelsea Gardens, London, S.W. 1. (1921.)
227. National Museum of Wales, Cardiff. (1924.)
228. Nash-Wortham, Mr J. R. H., Abingdon, Gatesden Road, Fetcham, Leatherhead, Surrey.

229. Nattrass, Mr R. M., B.Sc., (Agric.), Ph.D., Department of Agriculture, Nicosia, Cyprus. (1925.)
230. Nebraska, The Library, University of, Lincoln, Nebr., U.S.A. (1924.)
231. Nederlandsche Mycologische Vereeniging, c/o Dr A. J. P. Oort, Ericalaan 5, Wageningen, Holland. (1920.)
232. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904.)
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234. Noel, Miss E. F., F.L.S., 37 Burnham Court, Queen's Road, London, W. 2. (1913.)
235. North Carolina, Library, University of, Chapel Hill, North Carolina, U.S.A. (1920.)
236. Nursery and Market Garden Industries' Development Society, Ltd., Experimental and Research Station, Cheshunt, Herts. (1922.)
237. O'Connor, Mr P., Ph.D., B.Sc., A.R.C.Sc.I., National Museum, Dublin. (1925.)
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239. Oke, Mr Alfred William, B.A., F.G.S., F.L.S., 32 Denmark Road, Hove, Sussex. (1908.)
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241. Osborn, Professor T. G. B., D.Sc., F.L.S., Botanical Department, The University, Oxford. (1910.)
242. Ottawa, Ontario, Canada, The Library, Geological Survey. (1926.)
243. Oyler, Miss E., Experimental and Research Station, Cheshunt, Herts. (1937.)
244. Padwick, Dr G. Watts, Imperial Agricultural Research Institute, New Delhi, India. (1936.)
245. Page, Miss W. M., M.Sc., Ph.D., 19 Ledam Buildings, Bourne Estate, Holborn, London, E.C. 1. (1921.)
246. Park, Mr M., Department of Agriculture, Peradeniya, Ceylon. (1929.)
247. Parke Davis and Co., Medical Research Library, P.O. Box 488, Detroit, Michigan, U.S.A. (1920.)
248. Parker, Professor C. S., Department of Botany, Howard University, Washington, D.C., U.S.A. (1932.)
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251. Peklo, Dr Jaroslav, Professor of Applied Botany, Bohemian Technical University, Charles Square, Prague II, Czechoslovakia. (1924.)
252. Pershouse, Mrs Stanley, Denhem Lodge, Yelverton, S. Devon. (1937.)
253. Perthshire Society of Natural Science, c/o J. F. Cumming, Esq., 12 Barossa Place, Perth. (1919.)
254. Petch, Mr T., B.A., B.Sc., North Wootton, King's Lynn, Norfolk. (1911.)
256. Pethybridge, Mr G. H., Ph.D., D.Sc., F.L.S., Seofen, Moreton End Lane, Harpenden. (1919.)
257. Peyronel, Dr Benjamino, R. Istituto Sup. Agrario e Forestale, Piazzale del Re, Firenze, Italy. (1932.)
258. Philadelphia, The Academy of Natural Sciences of Philadelphia, Nineteenth and The Parkway, Phil., U.S.A. (1925.)
259. Phillips, Dr H. H., 6 St John's Road, Penge, London, S.E. 10. (1923.)
260. Ping, Mr A. Wentworth, M.A., "St Olave's", Clifton, York. (1926.)
261. Pollard, Mr S. C., Jesus College, Oxford. (1937.)
262. Potter, Rev. M. C., Sc.D., M.A., F.L.S., Corley Croft, New Milton, Hants. (1896.)
263. Preston, Mr N. C., B.Sc., Harper Adams Agricultural College, Newport, Salop. (1920.)
264. Pretoria, South Africa, The Chief, Division of Plant Industry (91403), Department of Agriculture. (1922.)
265. Purdue University, Library, Agricultural Experiment Station, Lafayette, Ind., U.S.A. (1931.)
266. Ramsbottom, Mr J., O.B.E., Dr. Sc., M.A., Pres.L.S., British Museum, (Nat. Hist.), Cromwell Road, South Kensington, London, S.W. 7. (1910.)
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270. Rees, Mr John, M.Sc., Adviser in Agricultural Botany, University College, Cardiff. (1929.)
271. Reichert, Dr Israel, Jewish Agency for Palestine, Agricultural Experiment Station, P.O.B., 15 Rehoboth, Palestine. (1924.)
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273. Robinson, Mr E., 26 Burwood Avenue, Eastcote, Pinner, Middlesex. (1938.)

274. Rothamsted Experimental Station, Department of Mycology, Harpenden, Herts. (1923.)
275. Rutgers College and State University of New Jersey, Library, New Brunswick, New Jersey, U.S.A. (1922.)
276. St Paul, Minnesota, U.W.A., The Library, Department of Agriculture University Farm. (1920.)
277. Salisbury, Professor E. J., D.Sc., F.R.S., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1921.)
278. Salmon, Professor E. S., F.L.S., South-Eastern Agricultural College, Wye, Kent. (1922.)
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289. Smith, Mr Rupert, 38 Greenhill Gardens, Edinburgh. (1927.)
290. South London Botanical Institute, 323 Norwood Road, Tulse Hill, London, S.E. 24. (1921.)
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292. Statham, Miss E. M., 2 Westbrook Road, Blackheath, London, S.E. 3. (1926.)
293. Stationery Office, H.M., Superintendent of Publications, Book Dept., Westminster, S.W. 1. (4 subscriptions.) (1920.)
294. Stephens, Miss E. L., B.A., Department of Botany, University of Cape Town, South Africa. (1928.)

295. Stephens, Miss F. L., M.Sc., Department of Botany, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W. 7. (1930.)
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299. Stirrup, Mr H. H., M.Sc., Midland Agricultural College, Sutton Bonnington, Loughborough. (1922.)
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302. Swanton, Mr E. W., M.B.E., A.L.S., Educational Museum, Haslemere, Surrey. (1899.)
303. Swedish Academy of Sciences, Royal, Stockholm, Sweden. (1919.)
304. Sydney, Australia, The Librarian, University of. (1922.)
305. Sydow, Herr H., Luitpoldstrasse 33, Berlin, W. 30, Germany. (1931.)
306. Tabor, Mr R. J., B.Sc., F.L.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1914.)
307. Tennessee, University of, Agricultural Experiment Station, Library, Knoxville, Tennessee, U.S.A. (1926.)
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310. Tomkins, Mr R. G., M.A., Ph.D., Trinity College, Cambridge. (1925.)
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314. Vanterpool, Mr T. C., M.Sc., Botanical Department, University of Saskatchewan, Saskatoon, Canada. (1929.)
315. Venkatarayan, Mr S. V., Senior Assistant Mycologist, Agricultural Department, Bangalore, S. India. (1935.)

316. Wadham, Professor S. M., M.A., Department of Agriculture, The University, Melbourne, Victoria, Australia. (1922.)
317. Wakefield, Miss E. M., M.A., F.L.S., Herbarium, Royal Botanic Gardens, Kew. (1911.)
318. Waldie, Mr J. S. L., B.Sc., C.D.A., Department of Agricultural Botany, The University, Reading. (1925.)
319. Wales, University College of, Librarian, Botanical Department, Aberystwyth, North Wales. (1927.)
320. Walker, Miss M. M., B.A., The Horticultural College, Swanley, Kent. (1937.)
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324. Wallis, Mr A., Westacre, Station Road, Kettering. (1921.)
325. Ware, Mr W. M., D.Sc., South-Eastern Agricultural College, Wye, Kent. (1924.)
326. Washington, Library, State College of, Pullman, Washington, U.S.A. (1924.)
327. Waterston, Mr J. M., B.Sc., Mycologist, Department of Agriculture, Paget East, Bermuda. (1934.)
328. Watson, Mr W., D.Sc., A.L.S., Cedene, Cheddon Road, Taunton. (1933.)
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333. Whetzel, Professor H. H., M.A., New York State College of Agriculture, Cornell University, Ithaca, N.Y., U.S.A. (1914.)
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343. Wisconsin, The Library, University of, Madison, Wis., U.S.A. (1923.)
345. Wolf, Mr B. L., N.D.A., Cornwall Buildings, 45 Newhall Street, Birmingham. (1923.)
346. Wood, Mr F. C., The Rest, Franklin Road, Durrington, Worthing. (1935.)
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352. Wyatt-Smith, Mr. J., Wadham College, Oxford. (1938.)
353. Yale University, Library, New Haven, Connecticut, U.S.A. (1930.)
354. Yeoman, Mr J. B., M.D., F.R.S.C., Norton, Wirral, Cheshire. (1934.)
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356. Zundel, Dr G. L. I., Botany Building, Pennsylvania State College, State College, Pa., U.S.A. (1929.)
357. Zürich, Switzerland, Botanical Garden and Museum, c/o Dr A. U. Däniker. (1921.)
358. Zürich, Institut für Spezielle Botanik der Eidg. Techn. Hochschule. (1928.)

Members are requested to report any errors or omissions in the list to Dr C. G. C. Chesters, The University, Birmingham.

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